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Just a Rhyme With a Reason

Phonological Similarity in L2 English in Metal Music: Examining Rhyming Patterns Across Native and Non-Native Speakers

MA Thesis Submitted By

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Abstract

This research examines the effect of L1 on perceived similarity in L2. Using data from rhymes in Metal music written in English, the research examines the different rhyming patterns of half-rhymes between speakers of Hebrew and German writing music lyrics in a similar L2 - English, and a control group of native English speakers writing in English. By examining a large-scale corpus, I suggest universals in rhyming patterns on one hand, such as similarity among sonorant consonants, alongside language-specific L1 effects such as vowels in Hebrew and final devoicing in German. All of these have a strong effect on the perceived similarity in L2.

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Chapter 1. Introduction

In modern society, monolingualism is scarce. Most of us are acquainted with at least one other language, and often - a third or more. Most speakers acquire L1 from birth and are proficient in it by an early age. L2, on the other hand, can be acquired or learned throughout the speaker's life, yet the production of L2 often shows residues from L1, which are more prominent the later the speaker was exposed to L2 (Flege et al. 1995). When examining *production*, such residues are distinct and are referred to as "accent". Contrary to production, however, such residues are more problematic to detect in L2 *perception*.

It is plausible that grammatical features of L1 can influence the perception of words in L2, the same way they affect production. A speaker might confuse words containing phonemes that do not exist in his native language or simply not know the difference. For example, in Hebrew there are no phonemic distinctions in vowel features like length and ATR. This might be the reason Hebrew speakers often have difficulty detecting length contrasts in English (in certain dialects), as in the words /ˈvɛːɹi/ 'very' and /ˈvɛɹi/ 'vary'.

Perceptual similarity might also be language dependent. Speakers perceive different levels of similarity for the same pairs of segments or words, depending on their native language. These differences can affect the speaker's ability to perceive and produce contrasts. For example, Hebrew speakers might have a difficulty perceiving, and even more producing, two different words in the minimal pair /*tɹi*/ 'tree' and /*θɹi*/ 'three', since the Hebrew phonemic inventory does not contain dental consonants, and thus speakers lack the distinction between alveolar and dental consonants.

There are several ways used to test and measure perceived similarity. Upon measuring perceived similarity and analyzing the features that affect said similarity, it is also possible to measure the effect of said features to discrimination. For example, if a measurement shows that /b/ is more similar to /p/ than it is to /m/, it indicates that nasality is a more crucial distinctive feature than voicing for that speaker. Such distinctions can be universal but can also be language specific, and in such cases, L1 might affect said perceived similarity in L2.

My study deals with the effect of L1 on perceived similarity in L2. Using rhymes as a measurement of perceived similarity, I will investigate similarity patterns in a specific language that is L2 for speakers of different L1s. By analyzing these similarity patterns, I will distinguish between features universally contributing to similarity and features contributing to similarity in a language specific manner. In this paper, I will present the corpus created for the full study and an analysis of the data and the conclusions drawn from it.

In §2, I will present the theoretical background for the research regarding similarity, rhyming, and various effects of L1 on L2. In §3, I will present the phonological theoretical background. §4 includes my research question and hypotheses. §5 presents methodology. §6 is the detailed description of the corpus built for the research. §7 presents the results of the data in the corpus divided by the three examined languages, and a detailed statistical analysis of the comparison among the three languages. §8 includes a discussion of the results. I conclude in §9.

Chapter 2. Theoretical Background

First and foremost, I will address the question of similarity itself - how to define two items as more or less similar? Similarity judgements may be context dependent. For example, a motorcycle is more similar to a car than a bicycle in the context of motor vehicles, but to a bicycle in the context of two-wheelers.

2.1. Phonological Similarity

There are several phonological models defining segmental similarity. Such similarity can explain a speaker's perception, production, ability to learn or acquire contrasts and so on. In the following section, I present some models of phonological similarity and suggested methods to examine it, some of which will be used in the current study.

2.1.1. Measuring Phonological Similarity

2.1.1.1. Sprachgefühl - Similarity Cannot be Measured

First, it is important to establish what phonological similarity is. Hyman (1970) claims that phonological similarity is something that can't be formulated phonologically, but rather, it depends on the "feeling" of the speakers. Speakers make similarity judgements based on Sprachgefühl, what "feels" right to them.

2.1.1.2. Counting Features - Similarity Can be Measured

Subsequent studies have presented models for the quantification of similarity. Frisch et al. (2004) presents a model which helps to assess the level of similarity between two segments, based on the counting of natural classes of features. This model was suggested to explain the OCP constraint, which requires adjacent segments to be as different as possible. He refers to it as a gradient constraint regarding Arabic

root forms, which requires a defined level of similarity. The level of similarity can be calculated using a formula:

$$Similarity = \frac{Shared\ natural\ classes}{Shared\ natural\ classes + Non{-}shared\ natural\ classes}$$

2.1.1.3. The P-map - a Map of Similarity

In many cases, the perception of different features appears to be context dependent. Steriade (2001) suggests the notion of the "P-Map", perception map. The P-map explains why some faithfulness constraints in OT are always ranked higher than others in certain contexts. For example, the markedness constraint preventing voiced obstruents word finally will always be resolved using final devoicing, and never deletion or epenthesis. This is because the output of voicing changes is deemed to be perceptually more similar than the output of deletion or epenthesis would have been. Therefore, the constraint preventing deletion or epenthesis word finally will always be ranked higher than the constraint preserving voice.

The P-Map proposes a universal ranking of faithfulness constraints for different contexts, based on the perceptibility of specific contours in such contexts. This idea affects similarity, in the notion that if a contour between two items is less perceptible, these two items are more similar. Similarity is not only dependent on features, but also on context. It might even differ between languages.

Steriade (2008) claims that the more similar segments are to one another, the closer they are in the P-map, the more confusable they are. For example, two interchanging items in slips of the tongue are more similar to one another than to other items which don't tend to do so. Therefore, slips of the tongue can be used to quantify the degree of similarity between items (see also Miller & Nicely 1955, Johnson 2012, among others).

Confusability, as suggested by Steriade, is one way to measure the rate at which two segments appear identical either in production (slips of the tongue) or perception (slips of the ear). There are, naturally, other methods to examine the rate at which two segments pass as identical such as in loanword adaptation, puns, rhyming etc.

2.1.2. Investigating Similarity

Several measures of similarity have been proposed. For example, Cohen (2009) examined similarity patterns using loanword adaptation in Hebrew. Loanword adaptation can be affected by many variables, besides phonological similarity, such as morphology, orthography, paradigm alignment and so on. Even though these are influential in loanword adaptation, phonological similarity is a major factor. When a word is loaned from one language to another, it should be as close as possible to its L2 source. The changes made to the word in the process of adaptation can be an indication of phonological similarity, determined by acoustic proximity.

Kawahara and Shinohara (2011) examined the similarity patterns in Japanese puns. A pun includes an alternation among words that sound alike, meaning, that could pass out as identical or near identical. Both the examination of loanwords and puns provide a good indication of alternations between segments that are nearly identical, thus being similar, determined by acoustic proximity.

2.1.3. Investigating Similarity Through Rhymes

Rhymes in poems, songs, and children's books, are an interesting indication of similarity. Maher (1969) noted that in some English poems and children's books, rhymes tend to either contain the exact same segments or some that differ in a single feature. This was shown as an indication of English speaker's awareness of said features in their native language.

Zwicky (1976) used that idea of imperfect rhyming patterns as an indication for segmental similarity. By examining rhymes in English rock songs, he concluded that certain segments are more likely to be perceived as rhymes than others and are therefore more similar to one another, determined by acoustic proximity. Zwicky's fundamental and groundbreaking research focused on the rhyming of English lyrics of English speakers.

Rhyming has often served as a popular research method for the investigation of phonological similarity. It has been widely tested through poetry (Holtman 1994, Steriade 2003, Horn 2010, Kern 2015, Topinzi et al. 2019 among others) and Hip-Hop (Kawahara 2007, Hirjee & Brown 2010, Katz 2015 among others), in various dialects of English, mainly referred to as Standard American English (SAE) and African American English (AAE), Japanese, Greek, Romanian and more.

The data collection in such research was mostly based on the listeners' intuition regarding musical rhymes. The researchers drew different conclusions regarding the source of similarity, whether it is based on the number of shared features, contextual perception, or a combination of both - a model like that of the P-map claiming the perceptibility of certain features in certain contexts affects similarity. Even though there are disagreements, there is one major consensus - rhyming reflects the knowledge of perceptual similarity.

I will adopt a terminology which uses the difference between two terms - 'rhyme' and 'rime'. A *syllabic rime* consists of the nucleus and the coda of a syllable (everything but the onset), and a *word rime* consists of the nuclei of the last stressed syllable and everything that follows (Katz 2015). A *rhyme* refers to the "correspondence in terminal sounds of units of composition or utterance (such as two

or more words or lines of verse)" as defined by Merriam-Webster dictionary. Usually, two words can be considered a *rhyme* when they have identical or similar *word rimes*. Rhymes appear in corresponding locations, usually the end of a line in songs, poems, and children's books.

A *perfect rhyme* contains identical *word rimes*, such as in the words /ɹɪˈ***vaɪv***/ 'revive' and /*səɹˈ****vaɪv***/ 'survive', in which the rhyme is both a syllabic and a word rime. In cases where the stressed syllable is not the ultimate syllable, all segments from the stressed nucleus onwards must be identical in both words, like in the rhyme /ˈ***fʌm.bəl***/ 'fumble' and /ˈ*kɹ****ʌm.bəl***/ 'crumble'. It is worth mentioning that there could also be a difference in stress patterns, but those are beyond the scope of this research.

An *imperfect rhyme* includes a difference in at least one segment between both parts of the rhyme, for example /***ɹɛst***/ 'rest' and /***pæst***/ 'past', which illustrate a difference in vowels between ɛ-æ. A rhyme can differ in more than one segment, and segments can, of course, differ in more than a single feature. While *perfect rhymes* contain identical segments, *imperfect rhymes* contain "similar" segments, thus allowing us to quantify segmental similarity. Such imperfect rhymes are the focus of this research.

2.2. The Effects of L1 on L2

The effects of similarity on perception in L2 were also examined. Flege (1987) and Best et al. (2001) showed that speakers categorize segments in a target language, which is not native, to those that are "closest" to segments available in their native language. This process is referred to as categorization - a speaker categorizes a linguistic acoustical cue into a phonemic category in his language. These studies examine the speaker's ability to categorize linguistic sounds that he is unfamiliar with.

These effects are not only indicated in unfamiliar languages, but also in learned L2. Jenkins et al. (1995) shows that speakers of L2 not only speak, but also listen with an accent. Some speakers, depending on their level of proficiency and exposure to L2, will have trouble in making distinctions that are not available in their L1. For example, speakers of languages such as Japanese, Cantonese, Korean which do not have a phonemic distinction between /l/ and /ɹ/ sounds, have trouble in making a distinction between words that differ in these sounds alone. These words can even appear homophonic to them, such as */ɹait/* 'write' - */lait/* 'light' (Flege 1987, Cutler & Otaka 2004, Cutler et al. 2006, Tyler 2020).

Others might perceive a different sequence, instead of one that is prevented by the grammar of L1. Dupoux et al. (2011) showed that speakers of Japanese and Brazilian Portuguese perceive an epenthetic vowel which is not uttered by the speaker, to prevent a sequence that is unavailable in the grammar of their L1.

Russak & Saiegh-Haddad (2011) showed that a phoneme that is available in L1 would be more accessible in L2 than one that isn't. They discuss the works of Wade-Woolly & Geva (2000) who suggest this difference exists in phonemic contrasts and phonological structures. Russak & Saiegh-Haddad (2017) and Saiegh-Haddad (2019) showed that while there is a universal tendency for specific phonological structures, there is an effect of L1 grammar on L2 phonological awareness. Eckman et al. (2003), following Major & Kim (1999), were able to show that it is harder to acquire contrasts between similar phonemes in L2, than dissimilar ones.

Chapter 3. Language Backgrounds

To best describe the differences among the three languages, I will describe the differences among their segmental inventories, both consonants and vowels. In addition, language-specific phenomena in the languages will be discussed. The data for this section were received from Dekel (2014), Bolozky (1997) for Hebrew. German in this paper is Standard High German (SHG or Hochesdeutsch) and the data for it is drawn from Mangold (1990). English in this paper is a form of SAE that exists as L2, and the data for it are derived from various sources including Fourakis (1991), Labov et al. (2008). Throughout this paper, the language names can appear shortened - EN for English, HE for Hebrew and DE for German.

3.1. English

3.1.1. English Consonantal Inventory

(1) English Consonantal Inventory:

	Labial		Coronal					Dorsal	Laryngeal
	Labial	Labio-Dental	Dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Glottal
Stops	**p b**			**t d**				**k g**	
Fricatives		**f v**	**θ ð**	**s z**	**ʃ ʒ**				
Affricates					**tʃ dʒ**				
Nasals	**m**			**n**				**ŋ**	
Trill									
Lateral				**l**					
Approx.						**ɹ**	**j**	**w**[1]	

English differs in all common places of articulation, as are displayed in table (1), except for glottal consonants. For some manners, affricates and lateral, the place of articulation is not a distinctive feature. Other interesting consonants are the approximants. The rhotic /ɹ/ is not always materialized as a full consonant and might attribute to the features of the adjacent vowel.

[1] Labio-Velar

3.1.2. English Vowel Inventory

(2) English Vowel Inventory:

		Front	Central	Back
High	+ATR	**iː**		**uː**
	-ATR	**ɪ**		**ʊ**
Mid-High		**e**		
Mid-Low	+ATR	**ɛː**	**ə**	**ɔ**
	-ATR	**æ**		
Low		**ʌ(a)**	**ɑ**	

The English vowel inventory differs among different researchers and dialects. The inventories differ in the available vowels, their exact locations, the distinctive features and so on. Here I used a standard 11 vowel system that is somewhat accepted as the SAE system and would suffice for this research.

The vowels differ in height and backness, back vowels are also rounded. The qualities of the /ʌ/ vowel differ between sources, and it received here the place of the cardinal /a/, in order to display that difference. The claims are that its place differs between the cardinals /a/ and /ʌ/, but the closest vowel in sound to it is /æ/.

English contains pairs of ±ATR, yet the vowels in English that are [+ATR] are also [+long]. English vowels do not differ in length except for the three pairs of vowels that differ in ATR. For simplicity, I will not show the length of vowels in this research. Vowels of [+ATR] are also [+long].

A note regarding the English rhotic: according to Lass (2006), there are major discussions regarding the pronunciation of the English rhotic following a vowel. According to his conclusion, there is a general realisation of the rhotic when it follows a vowel, which differs between low and non-low vowels. It is almost never realized as a full consonant but as an implication on the vowel. This implication is commonly referred to as “r-coloured vowel”. This is a variation among English dialects, as stated

in Labov et al. (2008). In general, a major part of UK English speakers omit the rhotic completely or create an “r-colored vowel” in some way.

For US English speakers, the situation is different and more complicated. Most speakers do pronounce the rhotic, except in specific cases such as appearing intervocalically and following a low vowel, and before another consonant, either inside or across word boundaries. The discussion in this research revolves around the perceived segments, and not produced. For this reason, and to create a homorganic comparison, a rhotic following a vowel in the same syllable will be addressed as a specific segment – an “r-coloured vowel”.

3.1.3. Interesting Phenomena in English – Vowel Reduction

Vowel reduction is a well known, highly productive phenomena in English as well as a large variation of other languages. Fourakis (1991) emphasizes the different definitions of the phenomena. Phoneticians refer to vowel reduction as the process that causes vowels to surface as schwa. Phonetitions, he claims, refer to it as the tendency of certain formants in vowels to fall short of fully materializing, causing the “overall shrinkage of vowel space”.

The result, Fourakis states, is nevertheless the same. Vowels in English are materialized as schwa in an unstressed position. This process is highly productive, yet some vowels and diphthongs are excluded from it. The back and rounded vowels /ɔ/, /u/ and /ʊ/, as well as the diphthongs /ɔɪ/ and /ɑʊ/ are excluded from it and tend to keep their features in unstressed positions.

3.2. German

3.2.1. German Consonantal Inventory

German shows differentiation in all common places of articulation, as are displayed in table (3), except for retroflex consonants. For some manners the place of

articulation is not a distinctive feature as there's only one consonant for said manner. The rhotic is the coronal trill, this is one of the features that can change in different dialects. There are also glottal consonants, a glottal stop and fricative. The only approximant is the glide /j/.

(3) German Consonant Inventory:

	Labial	Labio-Dental	Dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Glottal
Stops	**p b**			**t d**				**k g**	**ʔ**
Fricatives		**f v**	**θ ð**[2]	**s z**	**ʃ ʒ**		**ç**	**x**	**h**
Affricates					**t͡ʃ d͡ʒ**[3]				
Nasals	**m**		**n**					**ŋ**	
Trill			**r**						
Lateral			**l**						
Approx.							**j**		

3.2.2. German Vowel Inventory

(4) German Vowel Inventory:

		Front	Central	Back
High	+ATR	**i: y:**		**u:**
	-ATR	**ɪ Y**		**ʊ**
Mid-High		**e: ø:**		**o**
Mid-Low		**ɛ, ɛ: œ**	**(ə)**	**ɔ**
Low			**a, a:**	

In German, back vowels are also rounded. Aside from that, The German vowel system is a complicated one containing 16 vowels. Those differ in height, backness, roundness, ATR and length. The only two phonemic central vowels are also the only low vowels, and they differ only in length. The vowel /ə/ has a debatable phonemic status and it is considered as an unstressed allophone of /ɛ/.

The language has three pairs of vowels, all of them high, that differ in ATR and length - vowels that are [+ATR] are also [+long]. There are also two pairs of vowels

[2] The consonants /θ/ and /ð/ seem to appear as phonemes in German, yet some sources differ on it.
[3] The affricates appear in German, yet it is unclear whether they are phonemic or the combination of the relevant stops and fricatives. Those include t͡s, t͡ʃ, d͡ʒ and the highly marked p͡f that does not appear here, since it is claimed to exist only as two separate consonants.

that differ only in length, and not in ATR. Four pairs of vowels differ only in roundness.

German has the most complicated vowel system of all three languages, and the German speakers seem to phonemically distinguish between all the distinctive features that are available in the other languages. Some sources even claim a phonemic status to some nasal vowels that would differ only in nasality such as /ã:/.

3.2.3. Interesting Phenomena in German – Final Devoicing

As described in Brockhaus (1995), in German, a voiced obstruent turns voiceless in a word final position. This process is highly productive on both stops and fricatives, and even in loan words. There is a claim that normally consonant clusters agree in voicing, and thus a sonorant consonant in a word-final cluster would leave the entire cluster voiced, yet even this claim has contradicting data meaning all obstruents in world-final position, in all cases, are voiceless.

3.3. Hebrew

3.3.1. Hebrew Consonantal Inventory

(5) Hebrew Consonantal Inventory:

	Labial	Labio-Dental	Dental	Alveolar	Post-alveolar	Retroflex	Palatal	Velar	Uvular	Glottal
Stops	**p b**			**t d**				**k g**		**ʔ**
Fricatives		**f v**		**s z**	**ʃ ʒ**[4]			**χ**		**h**
Affricates				**t͡s**	**t͡ʃ d͡ʒ**					
Nasals	**m**			**n**						
Trill										
Lateral				**l**						
Approx.							**j**	**w**	**ʁ̞**	

Hebrew shows differentiation in all common places of articulation, as are displayed table (4), except for retroflex consonants. Hebrew also displays all the common manners of articulation as are displayed in the table, except for trill. Nasals

[4] The consonants /ʒ/ appear as a phoneme in Hebrew, yet only in loan words.

are only phonemic in two places – labial and coronal. The rhotic is a uvular approximant. There are also glottal consonants and approximants, a palatal glide /j/ and a velar /w/ with a labial secondary articulation.

3.3.2. Hebrew Vowel Inventory

(6) Hebrew Vowel Inventory:

	Front	Central	Back
High	**i**		**u**
Mid	**e**		**o**
Low		**a**	

Hebrew has a simple 5 vowel system. The vowels in Hebrew differ in height- high, mid and low. The distinction in backness is not definitive, as all front vowels are also unrounded, and back vowels are also rounded. The only central vowel is also the only low vowel. Hebrew speakers distinguish clearly only in height, while backness and roundness are a combined feature. Hebrew speakers do not differ in more marked features such as length, ATR or nasality.

3.3.3. Interesting Phenomena in Hebrew – Assimilation and Spirantization

Dekel (2014) shows the interesting variety of assimilations in Hebrew. Hebrew displays different types of consonantal assimilations, most of them are available in rapid speech such as degemination, voicing assimilation and nasal place assimilation. One type of assimilation, which Dekel referred to as assimilation in manner of articulation is spirantization.

Spirantization was a highly productive process in the early days of Modern Hebrew, but it was rendered unproductive in the past decades. It is perceived and described in normative Hebrew grammar books, but lately even claimed to be unapplicable in new loanwords. In Hebrew spirantization, the stops /b/, /p/ and /k/ turn into a fricative when following a vowel. An example for it is the paradigm of ‘laundry’ /**k**visa/ as opposed to ‘to do laundry’ /le**χ**abes/.

3.4. Comparison of the languages

3.4.1 Comparison of Consonants

All three languages distinguish consonants in the basic distinctive features of voice, place and manner of articulation. All three languages distinguish among labial, coronal and dorsal consonants, as well as within those groups. English is the only one with a distinct retroflex consonant, and the only that does not contain glottal consonants. Hebrew is the only language without distinction in dental consonants.

In the case of articulation, all three languages share most of the common manners. All languages share a similar inventory of stops, fricatives, affricates, lateral and approximants. German is the only language with a distinction of a trill consonant.

Both English and German contain three nasal phonemes, including /ŋ/. Hebrew contains only the two common /n/ and /m/, while /ŋ/ exists only as an allophone and it is not phonemic. Each language of the three has a different singular rhotic. For English, it is a retroflex approximant. In German it is a coronal trill, and in Hebrew a uvular approximant.

3.4.2 Comparison of Vowels

Vowel systems of all languages distinguish height. All languages differ in both backness and roundness, where in German it is a crucial distinctive feature but in English and Hebrew back vowels are also round. Hebrew does not distinguish in any other features. German and English vowels differ in ATR and length, in which vowels with [+ATR] are also [+long], this is of course dialect-dependent, yet German distinguishes in length in other cases while English does not.

The three languages also allow a wide range of diphthongs, differing based on dialects and other properties. The relevant diphthongs for this paper would be the rising diphthongs in English: /eɪ/, /aɪ/, /aʊ/, /oʊ/, and /ɔɪ/. The lowest requirement for a

diphthong to be accepted in each of the three languages, is that both vowels of the diphthong are licit vowels in the language.

Low vowels preceding a rhotic (/ɹ/) are affected by the quality of the rhotic, creating a "/ɹ/ colored vowel" as described previously. For this reason, a low vowel and the following rhotic will be addressed as a different vowel (e.g. /ɔɹ/).

Chapter 4. Research Question and Hypotheses

As I have shown, rhymes are a core indication of perceived segmental similarity. The perception of segmental similarity can affect the ability to discriminate between segments, acquire said segments and the contrast between them. In this study, I examine the perceived similarity between segments in one specific L2 for speakers of different L1s. I do so by investigating L2 rhyming patterns. I will discuss the segmental features that contribute to similarity for native speakers of the language and compare these to similar scales for speakers of different L1s.

The goal of this research is to determine whether some features cross-linguistically and universally contribute more to similarity than others. Do features that are distinctive in L1 contribute to the level of perceived similarity or dissimilarity in L2 or are similarity patterns universal?

4.1. Hypotheses

Given my research goal, I would examine the similarity of specific segments in rime position for a specific language, using the rhymes as an indication of similarity. This would result in similarity maps for native speakers, and for L2 speakers of said language. I would then compare the similarity patterns to one another.

Results will include a similarity pattern that is necessarily one of the following:

(1) *Same similarity pattern* - the similarity pattern of native speakers and of L2 speakers would be the same or without a statistically significant difference. This result could indicate a universal similarity scale.

(2) *Similar but different patterns* - the similarity patterns of native speakers and of L2 speakers are similar in order (specific features are more similar than others) but the degree of similarity differs by language of origin. This result

could indicate that the order of features is universal, but the weight of the features and their contribution to similarity may differ.

(3) *Different ordered patterns* - the order of features in the similarity patterns differs by language of origin. This result could indicate that perceived similarity is not universal, but language specific.

The results may consist of a combination of the hypotheses. Some features might cause universal similarity or dissimilarity, others might be universal in order but language specific in strength, or language specific both in order and in strength.

Chapter 5. Methodology

This thesis consists of a corpus study, containing rhymes made in English as L2 by speakers of different L1s. I collected rhymes that appear in metal songs written by singers with different L1s. The rhymes for each group of L1 speakers were examined and analyzed in comparison to itself, to speakers of English as L1 and to speakers of different L1s.

Using this analysis, I will be able to see how native speakers of different L1s perceive similarity patterns in one target L2. Through this, I can understand whether L1 influences perceived similarity and if so, how. In cases where there is a difference between said similarity patterns, it is probable the differences are caused by the specific L1 and are affected by its grammar. In cases where there is no difference between similarity patterns, such patterns are likely to be universal.

The attested similarity resulting in such an analysis is one of perceived similarity, regardless of the production itself. As I have stated above, rhymes are a representation of one's linguistic knowledge of similarity. The data collected from written lyrics are not necessarily a reflection of what actually constitutes a rhyme, but rather what the writer perceives as similar enough to rhyme.

5.1. The Music

I chose to work with metal music for several reasons. First, in marginal musical genres such as metal, many artists write in the world's *lingua franca* – English. The musicians wish to address a bigger audience and so they forgo writing in their native tongue. For that reason, the database of songs written in English as a second language is big and allows the creation of a large corpus comparing the same L2 (English) for musicians of varying L1s.

The second reason relates to Zwicky's (1976) choice of rock music. In rock and metal, as opposed to classic poetry and even popular music, the writing style is free and is not restricted to specific rhyming patterns, while still mostly displaying a simple structure. In addition, the high volume, distortion, and harsh singing (such as heavy metal "growls"), allow the writers to choose their rhymes more freely. They focus only on the characteristics of the segments as they perceive them, as such that would withstand these volumes. The third and most important reason is that this is my favorite type of music.

5.2. Examined Features

For each tested L1, specific features of the language can be examined. For example, devoicing that can affect the rhyming of voiced and voiceless consonants, spirantization can affect rhyming of stops and fricatives, and stress position could affect deletion or truncation. The segmental inventory and available contrasts are also examined.

This research focuses on English as an L2. Specific dialects are addressed but not examined, as the question regards the perception of English as L2 and not the production. The reference groups would consist of native speakers of Hebrew and German, all writing lyrics in English. As control groups for the rhyme patterns in English, two groups of English speakers were examined - one of American English speakers and one of British English speakers. The groups among themselves are as homogeneous as possible.

5.3. Method of Analysis

The data were collected from songs written by native speakers of Hebrew and German, written in English, and from two groups of English native speakers as control

groups. The written lyrics were collected from published online lyrics, validated in song listening and transcribed in the most common transcription using the online dictionary www.Dictionary.com.

A comparison was made between both rhyming words, marking the differences in rime position and dividing them to six groups:

1) *Perfect Rhyme* – All segments in the rime position of both words in the rhyme contain the exact same segments, with no alternation in features.
2) *Consonant Deletion* – Consonant appears in one of the words in the rhymed pair but does not have a correspondent in the second word.
3) *Consonant Alternation* – Consonant has correspondents in the rime position of both words of the rhyme, but with a difference in at least one feature between the two segments.
4) *Vowel Deletion* - Vowel appears in one of the words of the rhymed pair but does not have a correspondent in the second word.
5) *Vowel Alternation* - Vowel has correspondent in the rime position of both words of the rhyme, but those differ in at least one feature between the two segments.
6) *Truncation* - A syllable in the rime position of one of the words in the rhyming pair does not have a corresponding syllable in the second word of the pair.

Perfect rhymes are analysed as a part of the complete corpus for statistical information, but not considered in the research itself. All other groups, named combined 'imperfect rhymes', are analysed. The nature of syllables and segments deleted are counted, as well as the segments alternating and its nature.

The nature of alternation is compared to the expected alternation, derived from the frequency of appearance of each segment in the corpus using the Observed/ Expected statistical test. This helps determine whether the nature of alternation between segments is statistically expected, or rather lower or higher than expected.

An analysis to follow incorporates all the examined data including frequency of appearing segments, accessibility to speakers according to the L1 segmental and feature inventory, and the statistical analysis of their alternation. These will indicate the nature of alternating segments and features.

A comparison is then made between alternations according to their level of tendency, and between the languages of origin. The results of this comparison lead to the better understanding of universal features that contribute to similarity, and features that contribute to similarity in a language specific manner.

Chapter 6. The Corpora

6.1. Data Collection

For this study, I've used four groups of artists – two examined groups and two control groups. As will be described below, I attempted to create tested groups that are as homorganic as possible. The differences between the groups should be constricted to their native language. Some aspects of the differences within each group are controllable, such as home city to reflect dialect, age, and gender, and those will be described below. Other differences, such as age and source of L2, exposure to other languages, English vocabulary etc. are not controllable. This is a necessary concession in order to use genuine data from actual songs and not through a lab generated experiment.

The examined songs are in English, regardless of the artist's native language. [5] The full list of bands and singers is detailed in Appendix A. All the participants are both the main singers and main songwriters in their band. It is important to note that thanks to the dynamics of a heavy metal group, as opposed to performing artists in other genres, the main singer and song writer has a lot of influence on both the way the songs are being written and the way they are being recorded and performed. This influence exists even in songs written or sung by guest artists or another bandmember.

The database was collected from the entire discography (all albums released) for each artist, in which the relevant bandmember is the main singer and songwriter. To collect the rhymes, I listened to the songs while reading the lyrics, to find the exact

[5] In places the rhyming is referred to as "Hebrew" or "German", the reference is to the singer's native language and not the language of rhyming which is always English, unless stated otherwise.

places in which the words were meant to rhyme. The rhymes occur in a line-final position, either with the following line or in the known formation of ABAB or ABCB.

Each rhyme was marked as "perfect" or "imperfect" (difference of at least one segment between the two words consisting of a rhyme). The segmental changes were marked and classified for every vowel change or deletion and consonantal change or deletions. This was made to the lexical form of the words as the lyrics were written, without considering the actual performance, in order to examine the perception in the writing process, and not production in the performance.

In rare occasions, entire syllables were omitted and not referred to in the rhyme, such as in the case of the rhyme *ˈfɛər oʊ* 'Pharaoh' and *ˈreɪnˌboʊ* 'Rainbow' (HE, Subterranean Masquerade, For the Leader with String Music). In this case, it is possible to see the rhyme was supposed to be between the two final stressed syllables, and everything follows - *ɛər oʊ* and *oʊ*. Cases such as those might have been solved using stress shifting in the performance, but since I am examining the perception in the writing process and not in performance, I will address the created "problem" – imperfect rhyme, and not the "solution" of stress shifting.

In this case, the stressed syllable is "omitted" and ignored in the rhyme. I know this for two reasons. First, there is no syllable correspondence – there are two syllables in the rime position of the first word, but only one in the second word. Second, the final syllables in both words, that are a part of the rime position in both, are identical.

This can also happen between the stressed syllables, and not only the word final syllables, For example, *ˈdʌn dʒən* 'dungeon' and *kʌm* 'come' (DE, Disillusion, Back to the Times of Splendor). This is the same case, only with the stressed syllable, while

the unstressed syllable is ignored. In this case there is also an alternation between the nasals *n-m*.

These cases were scarce and will be dealt with in the analysis itself. In all other cases, there is a correspondence between the syllables which results in segmental alternations between rhyming pairs. For example, *əˈlaɪv* 'alive' and *skaɪz* 'skies' (EN–US, Trivium, Pillars of Serpents) which demonstrates an alternation between /v/ and /z/. Those alternations are the focus of the analysis of the full research.

6.2. Participants

The corpus consists of four groups – two tested groups and two control groups. The first group consists of 22 Hebrew speakers, singing in 21 heavy metal bands based in Israel. Of them, 19 are males and 4 are females. The artists were between the ages of 20-46 when the songs were released, average of 29. From this group, the corpus consists of 35 albums, to a total of 332 songs with 10,271 lines.

The second group consists of 8 German speakers, singing in 10 heavy metal bands based in Germany. Of them, 5 are male and 3 are females. The artists were between the ages of 20-50 when the songs were released, average of 32.6. From this group, the corpus consists of 41 albums, to a total of 381 songs with 11,683 lines. The reason for the difference in the number of artists comes from the supply of available songs and albums. While the average number of albums per Hebrew speaking artist is 1.59, the average number of albums per German speaking artist is 4.5. This results in a difference in the amount of words per speaker.

The first control group consists of 3 American male English speakers, all based in Tampa, Florida. The artists were between the ages of 17-51, average of 28.95 when

the songs were released. From this group, the corpus contains 21 albums, to a total of 226 songs with 5,335 lines.

The second control group consists of 3 British male English speakers, all based in London, England. The artists were between the ages of 21-63, average of 36.59 when the songs were released. From this group, the corpus contains 27 albums, to a total of 189 songs with 5,123 lines. Both control groups create an English corpus to which I can compare rhyming patterns. In all 4 groups, artists were chosen according to specific home areas to avoid differences in accent as much as possible.

From those 4 groups I have created a corpus of rhymes, pairs of words that appeared in the defined structure to create a rhyming pattern in a song, to the best perception of the songwriter. The complete corpus contains 2,381 pairs of words from Hebrew speakers, 3,154 pairs of words from German speakers, 1,643 pairs of words from US English speakers and 1,716 pairs of words from UK English speakers. A total of 5,535 pairs of words from the tested groups (Hebrew and German) and 3,359 pairs of words in the control groups, from English speakers. The full corpus contains 8,894 pairs of words.

6.3 The Final Corpus

Upon completion, the Hebrew database consisted of 2,381 rhymes, 1,250 (53%) of which were imperfect. The German database consisted of 3,154 rhymes, 1,636 (52%) of which were imperfect. For US speakers, the corpus consists of 1,643 rhymes, of which 972 (59%) are imperfect. For UK speakers, the corpus consists of 1,716 rhymes, 980 (57%) are imperfect to a total of 1,952 (58%) imperfect rhymes by English speakers. As is noticeable, over half the rhymes in all groups are imperfect, with no regards to the native language of origin.

This is an indication of the rhyming nature, either in metal music or in modern music in general. Mainly, regarding the free writing patterns, in correlation with complicated themes, as opposed to more classical music or of popular nature. Another important reason is that heavy metal music consists of a lot of ‘noise’. The loud music and harsh vocals are a perfect environment for imperfect sound, as they mask all disturbances. The singers are free to leave only important properties that would contribute to similarity, such as stress, vowels, and major features in consonants, instead of insisting on perfect rhymes. The identification of these “important properties” are the result of this study.

Chapter 7. Results

In the following section, I will present the results of the research divided by the three examined languages. In the last part of this section, I will show a full analysis comparing the results of the three languages.

7.1. Hebrew Results

In the created corpus, Hebrew speakers resulted in 2,381 pairs of rhymes. Out of these, 1,131 are perfect, resulting in 53% (1,250) pairs of imperfect rhymes. Of these, 640 (51%) include at least one consonant or vowel deletion, for example ‘strength’ /stɹ**ɛŋθ**/ and ‘breath’ /bɹ**ɛθ**/ (HE, Shredhead, ‘Death Row’). In this example, /ɛŋθ/ is in one rime position and /ɛθ/ is in the other, i.e. a deletion of the segment /ŋ/.

Of the rhyming pairs, 546 (44%) include at least one alternation in consonants. For example, ‘club’ /klʌb/ and ‘love’ /lʌv/ (HE, OMB, ‘Oh Mrs. Wade! You Shouldn't Have!). 612 (49%) include at least one alternation in vowels. For example, ‘fed’ /fɛd/ and ‘sad’ /sæd/ (HE, Structural, ‘Utopia’), i.e. an alternation of /ɛ/ and /æ/.

912 (73%) include an alternation in a stressed syllable of the rhyme, while only 85 (7%) include an alteration in an unstressed syllable. For example, ‘Lilac’ /ˈlaɪ lək/ and ‘Delilahs’ /dɪˈlaɪ ləz/ (HE, OMB, ‘Mother Gazelle Father Horse’) which demonstrate an alternation of /k/ and /z/, in an unstressed position. Most rhyming pairs include more than one alteration or deletion.

Most changes in consonants occur in coda position, while only 1% of alternations and 5% of deletions occur in onset position. In the following sections of all languages, the onsets were omitted from the calculations and the numbers of both existing consonants in the corpus and changes between rhyming pairs address only consonants in coda positions.

7.1.1. Deletions

7.1.1.1. Vowel Deletions

Over all, 36 stressed vowels were deleted, and an additional 24 unstressed vowels were deleted. This makes a total of 60 vowels, out of 5,645 vowels in the corpus, about 1%. The most frequently deleted vowel is the reduced vowel /ə/, mostly in its appearance with the following /ɹ/ - /əɹ/. /əɹ/ was deleted 23 times in a stressed position and 8 times in an unstressed position to a total of 10% of its appearances. In addition, /ə/ was deleted 14 times in an unstressed position to a total of 5% of its appearances. For example, ‘fool’ /ful/ and ‘cruel’ /ˈkɹu əl/ (HE, Sinnery, ‘Black Widow’). In some dialects of English /ə/ is deleted, meaning in those cases the two words are considered a perfect rhyme.

(7) Hebrew Vowel Deletions

Stressed vowel deletions		**Unstressed vowel deletions**	**Total Deletions**	**Total Vowel appearance**	**Percentage out of vowel’s appearances**
əɹ	23	8	31	322	10%
ə	0	14	14	260	5%
ʊ	1	0	1	18	5%
i	7	0	7	570	1%
u	1	0	1	160	0.6%
ɪ	1	2	3	556	0.5%
ɔ	1	0	1	258	0.3%
ɛ	1	0	1	477	0.2%
eɪ	1	0	1	733	0.1%
Undeleted vowels		ɒ, e, ɑ, ʌ, æ, aɪ, aʊ, əʊ, oʊ, ɑr, ɜɪ, ɔɪ, ɔɪ, ɛɹ, ɛɪ		2,291	0%
Sum	36	24	60	5,645	1%

Another interesting deletion is that of the vowel /i/, which is deleted 7 times in a stressed position only, to a total of 1% of its appearances. For example, ‘in’ /ɪn/ and ‘being’ /ˈbi ɪŋ/ (HE, Walkways, ‘Thoughts’) which demonstrates a deletion of /i/ as

well as an alternation between /n/ and /ŋ/. /ɪ/ is deleted twice in an unstressed position, and once more in a stressed position, in 0.5% of its appearances. For example, ‘ruins’ /ˈɹu ɪnz/ and ‘goons’ /gunz/ (HE, Dark Serpent, ‘Defiance’). Other deleted vowels were only deleted once in a stressed position - /ɛ/, /ɔ/, /u/, /ʊ/ and the diphthong /eɪ/. Table 7 shows the distribution of Hebrew vowel deletions.

Generally vowels are deleted in the corpus in cases of hiatus as in the given examples. Out of 60 vowels deleted, 65% (39) are deleted in a case of hiatus, while only 35% (21) are deleted without hiatus. This is a common environment for vowel deletion in rapid speech as well, which makes the results rather expected.

7.1.1.2. Consonant Deletions

A total of 655 consonants were deleted in stressed syllables, and an additional 34 consonants were deleted in unstressed syllables, to a total of 689 deleted consonants out of 5,082 consonants in the corpus, 14% deleted of all consonants. A few consonants are deleted in large numbers, and those can be divided into two major groups - a morphological group of inflectional suffixes, and a phonological group of sonorant consonants.

Inflectional suffixes in the case of consonant deletion include, for the case of this study, four consonants - /z/ and /s/, which indicate plurality, or less commonly in the data - possession and 3rd present person, and /d/ and /t/ which indicate past tense. The two allomorphs per suffix are derived from a voicing assimilation which occurs in English. For example, ‘hands’ /hændz/ and ‘sand’ /sænd/ (HE, Sinnery, ‘Holes’) and ‘brave’ /bɹeɪv/ and ‘saved’ /seɪvd/ (HE, Magor, ‘Misanthropic Divine Supervision’) This was mentioned by Zwicky (1976) as a probable reason for deletion of those

specific consonants. Other interesting suffixes are /əɹ/ which was formerly mentioned as a comparative marker, and the syllable /ɪŋ/ which forms present participles.

(8) Hebrew Consonant Deletions

Cons.	Stressed	Unstressed	Total appearances	Percentage (of appearances)
ɹ	3	0	8	37.5%
z	172	13	572	32%
g	4	0	16	25%
d	120	4	755	16%
s	65	2	459	15%
p	9	0	67	13%
f	7	0	64	11%
n	119	6	1145	11%
ð	2	0	19	10%
l	47	1	479	10%
v	13	1	144	10%
t	45	4	565	9%
ŋ	10	3	161	8%
k	13	0	184	7%
m	20	0	282	7%
θ	3	0	62	5%
d͡ʒ	1	0	30	3%
b	0	0	6	0%
j	0	0	0	0%
t͡ʃ	0	0	20	0%
ʃ	0	0	37	0%
w	0	0	0	0%
ʒ	0	0	7	0%
Sum	655	34	5,082	14%

The four single consonants were deleted in high numbers and included 172 deletions of /z/ in stressed position and additional 13 in unstressed position to a total of 185 deletions, 32% of the consonant's appearance - the largest amount in both

numeric and percentage values (excluding /ɹ/ to be discussed later). Only 17 deletions (9% out of /z/ deletions) occurred in cases of which /z/ did not act as a suffix.

120 deletions of /d/ in stressed position and additional 4 in unstressed position to a total of 16% of occurrences. In this case, 78 cases of the deletions (63%) did not involve a suffix. 65 deletions of /s/ in stressed position and additional 2 in unstressed position to a total of 15% of occurrences, 21 of those (31%) did not involve a suffix. 47 deletions of /t/ in stressed position and additional 4 in unstressed position to a total of 9% of occurrences - not a high number in terms of percentage, of which 44 (86%) did not involve a suffix.

The appearance of the highly deleted consonants as suffixes shows an interesting division. The highly common /z/ suffix is highly deleted in suffix position. This large correlation is a good indication of causality. For the other inflectional suffixes, the correlation is not as high and might not be the cause for the high rates of deletion. The causes can also be their high rate of appearances - while the numeric value of deletions is high, the percentage is rather close to that of other segments.

Another interesting group is the phonological group of sonorant consonants, which include /ɹ/, /l/, /n/, /m/, and /ŋ/. This group includes 119 deletions of /n/ in stressed position and additional 6 in unstressed position to a total of 11% of occurrences, 47 deletions of /l/ in stressed position and additional 1 in unstressed position to a total of 10% of occurrences, 20 deletions of /m/ in stressed position to a total of 7% of occurrences, 10 deletions of /ŋ/ in stressed position and additional 3 in unstressed position to a total of 8% of occurrences. It is worth mentioning /ɹ/, which was deleted 3 times in a stressed position to a total of 37.5% of occurrences. This high percentage is caused by the low number of appearances in the corpus.

In very few cases, an entire syllable was deleted. This happens 23 times in the entire corpus, 0.01% of rhymes include a syllable deletion. This is only accounted for in cases where there is no correspondence in syllable number between two words of a rhyme in rime position. For example, ‘Darkness’ /ˈdɑɹk nɪs/ and ‘viciousness’ /ˈvɪʃ əs-ˌnɪs/ (HE, Prey For Nothing, ‘Violence Divine’). In this case there is a clear correspondence between part of the rime in word A and the entire rime in word B, excluding the first syllable /dɑɹk/. 16 of the cases occur in stressed syllables such as in the given example, and only 7 of the cases occur in unstressed syllables, for example ‘me’ /mi/ and ‘being’ /ˈbi ɪŋ/ (HE, Sinnery, ‘Mouthful of Nails’).

Clusters occur in coda position, in at least one of the words in a rhyming pair, in 30% of the rhymes and in 44% of imperfect rhymes. Only in 42 cases (8%), the cluster was kept and the changes which caused imperfection were in another segment such as the preceding vowel, a coda of another syllable etc. In 33% of the cases (183), at least one of the consonants in the cluster changed. This can happen in addition to deletion of one of the consonants.

In 37 (7%) of the cases, the entire cluster was deleted. In 427 cases (78%) a part of the cluster was deleted. In most cases, 251 (59% of clusters in which some of the segments were deleted), the end of the cluster was deleted. In 164 cases (38%), the beginning of the cluster was deleted. In a few single cases, the deletion occurred either in the middle - C2 deleted while C1+C3 are kept (8 cases, 2%), or at both edges - C1+C3 are deleted while C2 is kept (4 cases, 1%).

An interesting observation is that of the segments deleted in different positions of the cluster. There appears to be a preference for sonorant consonants to be deleted

at the beginning of the cluster, while obstruents are mostly deleted at the end of the cluster which is the less prominent position. For example, /n/ was deleted 82 times at the beginning of a cluster but only once at the end, and /l/ was deleted 30 times at the beginning of a cluster but only once at the end. On the other hand, /d/ was deleted 104 times at the end of a cluster and /z/ was deleted 85 times at the end, both were only deleted twice at the end of a cluster. These data may indicate an interesting way for a language to deal with unwanted clusters, and can be the subject of further research.

7.1.2. Alternations

Alternation was marked when there was a corresponding segment in both words of the rhyming pair, but those segments are not identical.

The expected ratio of each alternation is determined by the following formula -

$$Expected\ ratio = \left(\frac{Appearances\ of\ segment\ A}{Total\ segments\ (consonants\ or\ vowels)} * \frac{Appearances\ of\ segment\ B}{Total\ segments\ (consonants\ or\ vowels)} \right)/2$$

This makes the multiplied percentage of each segment out of the total, divided by 2 as each rhyming pair is made out of 2 groups of segments. The statistical significance of each connection between observed and expected will be discussed under language comparison.

As demonstrated by Frisch, by dividing the number of observations in the number of expected appearances - O/E, this allows to demonstrate a ratio of similarity. When O/E>1 the segments are similar, while with O/E<1, segments are dissimilar.

7.1.2.1. Vowel Alternations

A large majority of the alternating vowels included an alternation between vowels barring primary stress. Only in 6% of the alternations (37 cases) an alternation was made between primary and secondary secondary stress, and in one case only (>1%), an alternation was made between two vowels barring secondary stress.

(9) Hebrew Common Vowel Alternations

Vowel 1	Vowel 2	Observed	Expected	O/E Value
ɪ	i	78	28.12	2.77
æ	ɛ	56	12.28	4.56
oʊ	ɔ	54	8.41	6.42
eɪ	ɛ	52	31.03	1.7
eɪ	æ	28	18.83	1.49

The most common vowel alternations are /ɪ/ and /i/, which alternate 76 times in stressed syllables, and twice in unstressed syllables. For example, ‘been’ /bɪn/ and ‘seen’ /sin/ (HE, DPS, ‘Rise and Fall’). The expected ratio for this alternation, according to the number of occurrences of each vowel, is only 28 times. Other common alterations are /æ/ and /ɛ/, which alternated 56 times in stressed syllables with the expected ratio of 12 times, /ɔ/ and the diphthong /oʊ/ which alternate 54 times in stressed syllables and /ɛ/ and the diphthong /eɪ/ which alternate 52 times in stressed syllables with the expected ratio of 31 times. One other mentionable alternation is that of /æ/ and the diphthong /eɪ/ which alternate 28 times in stressed syllables with the expected ratio of 19 times.

(10) Hebrew Uncommon Vowel Alternations

Vowel 1	Vowel 2	Observed	Expected	O/E Value
eɪ	ɪ	11	36.16	0.3
eɪ	i	9	37.01	0.24
aɪ	ɪ	4	40.85	0.1
aɪ	i	2	41.80	0.05
eɪ	aɪ	0	53.76	0

Interestingly uncommon alterations involve the vowels /i/ and /ɪ/ and the diphthongs /aɪ/ and /eɪ/ in several combinations. /eɪ/ and /ɪ/ are expected to alternate 36 times, but only do 11 times. /eɪ/ and /i/ are expected to alternate 37 times, but only

do 9 times. /aɪ/ and /ɪ/ are expected to alternate 41 times, but only do 4 times. /aɪ/ and /i/ are expected to alternate 42 times, but only do twice. Most interesting are /eɪ/ and /aɪ/ which are expected to alternate 54 times, but do not alternate at all.

7.1.2.2. Consonant Alternations

The most common consonant alternations are /n/ and /m/, which alternate 78 times in stressed syllables, and 3 times in unstressed syllables. The expected ratio for this alternation is only 32 times. For example, 'obscene' /əbˈsin/ and 'dream' /dɹim/ (HE, Betzefer, 'Early Grave'). Another common alternation is /s/ and /z/, which alternate 30 times in stressed syllables, and 4 times in unstressed syllables, with the expected ratio of 26 times. Another rather common alternation are /t/ and /d/, which alternated 32 times in stressed syllables, and 2 times in unstressed syllables, with the expected ratio of 42 times. For this alternation, while common, O/E value is of <1, meaning the consonants are not as similar as expected.

(11) Hebrew Common Consonant Alternations

Cons. 1	**Cons. 2**	**Observed**	**Expected**	**O/E Value**
n	m	81	31.77	2.55
t	d	34	41.97	0.81
z	s	34	25.83	1.32

Interestingly uncommon alternations are of /s/ and /n/ are expected to alternate 52 times, but only do 4 times. Other uncommon alternations include /z/ and /l/ which are expected to alternate 27 times, but do not alternate at all. /t/ and /l/ are expected to alternate 27 times, but only do 5 times. /t/ and /s/ are expected to alternate 25 times, but only do 5 times. /s/ and /d/ are expected to alternate 34 times, but only do 3 times. /l/ and /d/ are expected to alternate 36 times, but only do 5 times. /l/ and /n/, which alternated 29 times in stressed syllables, and once in unstressed syllables, with the

expected ratio of 54 times. /t/ and /z/ are expected to alternate 32 times, but only do 5 times. /z/ and /n/ are expected to alternate 64 times, but only do 10 times. /z/ and /d/ which alternate 22 times in stressed syllables with the expected ratio of 42 times. Most interesting are /t/ and /n/ are expected to alternate 64 times, but only do 6 times.

(12) Hebrew Uncommon Consonant Alternations

Cons. 1	Cons. 2	Observed	Expected	O/E Value
s	n	4	51.71	0.08
z	l	0	26.96	0
t	l	5	26.63	0.19
t	s	5	25.52	0.2
s	d	3	34.10	0.09
n	l	30	53.96	0.55
z	t	5	31.80	0.16
z	n	10	64.44	0.15
z	d	22	42.49	0.52
t	n	6	63.65	0.09

The full data of alternations and expected ratio is available in Appendix B.

7.2. German Results

In the created corpus, German speakers resulted in 3,154 pairs of rhymes. Out of these, 1,518 are perfect, resulting in 52% (1,636) pairs of imperfect rhymes. Of these, 870 (53%) include at least one consonant or vowel deletion, for example ‘silence’ /ˈsaɪ ləns/ and ‘violence’ /ˈvaɪ **ə** ləns/ (DE, Alkaloid, ‘A Fool's Desire’). In this example, the reduced vowel /**ə**/ is deleted between the rhymes, as it exists in one word of the rhyme but does not exist in the second.

Of the rhyming pairs, 797 (49%) include at least one alternation in consonants. For example, ‘burden’ /ˈbɜɪ d**n**/ and ‘hurdles’ /ˈhɜɪ d**l**z/ (DE, Beyond the Black, ‘Love is a Burden’). This example also includes a deletion of the segment /z/ which

demonstrates a deletion of the plurality suffix. 590 (36%) include at least one alternation in vowels. For example, ‘megalomania’ /ˌmɛg ə loʊˈmeɪ n**i** ə/ and ‘necromania’ /ˌnɛkɹəʊˈmeɪ n**ɪ** ə/ (DE, Dark Fortress, ‘Swan Song’), which demonstrate an alternation of /i/ and /ɪ/. 1,127 (69%) include an alternation in a stressed syllable of the rhyme, while only 73 (4.5%) include an alteration in an unstressed syllable. Most rhyming pairs include more than one alteration or deletion.

Most changes in consonants occur in coda position, while only 8% of alternations and deletions occur in onset position. In the following sections, the onsets were omitted from the calculations and the numbers of both existing consonants in the corpus and changes between rhyming pairs address only consonants in coda positions.

7.2.1. Deletions

7.2.1.1. Vowel Deletions

Over all, 26 stressed vowels were deleted, and an additional 63 unstressed vowels were deleted. This makes a total of 89 vowels, out of 7,665 vowels in the corpus, about 1%. The most frequently deleted vowel is the reduced vowel /ə/, mostly in its appearance with the following /ɹ/ - /əɹ/. /əɹ/ was deleted 30 in an unstressed position to a total of 7% of its appearances. In addition, /ə/ was deleted 22 times in an unstressed position to a total of 5% of its appearances.

Another interesting deletion is that of the vowel /ɛɹ/ which is deleted 4 times in a stressed position to a total of 2% of its appearances. Other interesting cases include /ɑɹ/ which is deleted 3 times in a stressed position also to a total of 2% of its appearances. /i/, which is deleted 6 times in a stressed position and twice more in an unstressed position, to a total of 0.9% of its appearances. /ɪ/ is deleted 6 times in an unstressed position only, in 0.75% of its appearances. Other deleted vowels were only deleted in a very low percentage of appearances - the diphthong /aɪ/, or only once or

twice - /ʊ/, /ɔ/, /ɛ/, and the diphthongs /eɪ/, /oʊ/, /ɔɹ/, /ɔɪ/. Table 13 shows the distribution of German vowel deletions.

(13) German Vowel Deletions

Stressed vowel deletions		**Unstressed vowel deletions**	**Total Deletions**	**Total Vowel appearance**	**Percentage out of vowel's appearances**
əɹ	0	30	30	429	7%
ə	0	22	22	430	5%
ʊ	1	0	1	20	5%
i	6	2	8	934	0.9%
ɪ	0	6	6	804	0.75%
ɔ	1	0	1	308	0.3%
ɛ	2	0	2	573	0.35%
eɪ	1	0	1	856	0.1%
aɪ	4	0	4	1167	0.3%
ɑɹ	3	0	3	163	2%
ɛɹ	4	0	4	170	2%
oʊ	1	1	2	439	0.5%
ɔɹ	2	0	2	223	9%
ɔɪ	0	1	1	48	2%
Undeleted vowels		ɒ, e, ɑ, u, ʌ, æ, aʊ, əʊ, ɛɪ		1101	0%
Sum	25	62	87	6,564	1%

Generally, vowels are deleted in the corpus in cases of hiatus as in the given examples. Out of 89 vowels deleted, 52% (46) are deleted in a case of hiatus, and 48% (43) are deleted without hiatus.

7.2.1.2. Consonant Deletions

A total of 862 consonants were deleted in stressed syllables, and an additional 53 consonants were deleted in unstressed syllables, to a total of 915 deleted consonants out of 6,634 consonants in the corpus, 14% deleted of all consonants. A few consonants are deleted in large numbers, and those can be divided into two major

groups - a morphological group of inflectional suffixes, and a phonological group of sonorant consonants, same as the case in the results of Hebrew speakers.

(14) German Consonant Deletions

Cons.	Stressed	Unstressed	Total Deletions	Total appearances	Percentage (of appearances)
b	2	0	2	6	33%
z	230	14	244	797	31%
d	154	9	163	887	18%
f	14	0	14	83	17%
s	75	4	79	575	14%
ɹ	1	0	1	8	12.5%
k	24	1	25	203	12%
l	69	5	74	620	12%
t	85	7	92	759	12%
p	12	0	12	113	11%
v	25	0	25	223	11%
ʒ	1	0	1	9	11%
n	118	8	126	1470	9%
m	35	0	35	370	9%
θ	6	0	6	64	9%
ʃ	3	0	3	38	8%
g	1	0	1	14	7%
d͡ʒ	2	1	3	52	6%
ŋ	5	4	9	302	3%
Undeleted Consonants			ð, j, t͡ʃ, w	41	0%
Sum	862	53	915	6,602	14%

The four single consonants were deleted in high numbers and included 230 deletions of /z/ in stressed position and additional 14 in unstressed position to a total of 244 deletions, 31% of the consonant's appearance - the largest amount in both numeric and percentage values (excluding /b/ to be discussed later). Only 15 deletions, 6% out of /z/ deletions, occurred in cases of which /z/ did not act as a suffix.

154 deletions of /d/ in stressed position and additional 9 in unstressed position to a total of 18% of occurrences. In this case, 117 cases of the deletions (72%) did not involve a suffix. 75 deletions of /s/ in stressed position and additional 4 in unstressed position to a total of 14% of occurrences, 41 of those (52%) did not involve a suffix. 85 deletions of /t/ in stressed position and additional 7 in unstressed position to a total of 12% of occurrences, of which 81 (88%) did not involve a suffix. The division of those deleted consonants is similar to that in the results of Hebrew Speakers.

Another interesting group is the phonological group of sonorant consonants, which include /ɹ/, /l/, /n/, /m/, and /ŋ/. This group includes 118 deletions of /n/ in stressed position and additional 8 in unstressed position to a total of 9% of occurrences, 69 deletions of /l/ in stressed position and additional 5 in unstressed position to a total of 12% of occurrences, 35 deletions of /m/ in stressed position to a total of 9% of occurrences, 5 deletions of /ŋ/ in stressed position and additional 4 in unstressed position to a total of 3% of occurrences, which is not high in both percentage and numeric values.

Two consonants are worth mentioning - /ɹ/, was deleted once in a stressed position to a total of 12.5% of occurrences. /b/ was deleted twice in a stressed position to a total of 33% of occurrences. This high percentage is caused by the low number of appearances in the corpus.

In very few cases, an entire syllable was deleted. This happens 52 times in the entire corpus, meaning, 0.02% of rhymes include a syllable deletion. 35 of the cases occur in stressed syllables and only 17 of the cases occur in unstressed syllables.

Clusters occur in coda position, in at least one of the words in a rhyming pair, in 26% of the rhymes and in 48% of imperfect rhymes. Only in 37 cases (6%), the cluster was kept and the changes which caused imperfection were in another segment such as the preceding vowel, a coda of another syllable etc. In 10% of the cases (66), imperfection was caused due to a consonant change, and not deletion.

In 48 (8%) of the cases, the entire cluster was deleted. In 470 cases (75%) a part of the cluster was deleted. In most cases, 303 (64% of clusters in which some of the segments were deleted), the end of the cluster was deleted. In 142 cases (30%), the beginning of the cluster was deleted. In a few single cases, the deletion occurred either in the middle - C2 deleted while C1+C3 are kept (17 cases, 4%), or at both edges - C1+C3 are deleted while C2 is kept (8 cases, 2%).

The same observation that was made in Hebrew results applies here as well - different segments are deleted in different positions of the cluster. There appears to be a preference for sonorant consonants to be deleted at the beginning of the cluster, while obstruents are mostly deleted at the end of the cluster which is the less prominent position. For example, /n/ was deleted 71 times at the beginning of a cluster but none at the end, and /l/ was deleted 21 times at the end of a cluster but only once at the end. On the other hand, /d/ was deleted 87 times at the end of a cluster but only 3 times in the beginning, and /z/ was deleted 142 times at the end, both were only deleted 5 times at the end of a cluster.

7.2.2. Alternations

Alternation was marked when there was a corresponding segment in both words of the rhyming pair, but those segments are not identical. The formula for O/E values was presented in previous result sections.

7.2.2.1. Vowel Alternations

A large majority of the alternating vowels included an alternation between vowels barring primary stress. Only in 8% of the alternations (50 cases) an alternation was made between primary and secondary secondary stress, and in 8 cases only (1%), an alternation was made between two vowels barring secondary stress.

(15) German Common Vowel Alternations

Vowel 1	**Vowel 2**	**Observed**	**Expected**	**O/E Value**
æ	ɛ	59	10.61	5.55
ɪ	i	48	48.98	0.97
eɪ	ɛ	45	31.99	1.4
ʌ	ɔ	36	6.58	5.46
oʊ	ɔ	27	8.82	3.06
ʌ	ɑ	24	2.56	9.34

The most common vowel alternations are /æ/ and /ɛ/, which alternate 59 times in stressed syllables. The expected ratio for this alternation is only 11 times. Other common alterations are /ɪ/ and /i/, which alternate 45 times in stressed syllables, and 3 times in unstressed syllables with the expected ratio of 49 time. /eɪ/ and /ɛ/, which alternated 45 times in stressed syllables with the expected ratio of 32 times, /ʌ/ and /ɔ/ which alternate 36 times in stressed syllables with the expected ratio of 7 times. Other mentionable alternation are /oʊ/ and /ɔ/ which alternate 27 times in stressed syllables,with the expected ratio of 9 times, and /ʌ/ and /ɑ/ which alternate 23 times in stressed syllables and once more in an unstressed syllable, with the expected ratio of 3 times.

Interestingly uncommon alterations include the vowels /aɪ/ and /i/ which are expected to alternate 71 times, but only do so 4 times. /aɪ/ and /ɪ/ are expected to

alternate 61 times, but only do 3 times. /eɪ/ and /aɪ/ are expected to alternate 65 times, but only do 4 times. /aɪ/ and /ɛ/ are expected to alternate 44 times, but only do twice. /i/ and /ɛ/ are expected to alternate 35 times, but only do twice. Most interesting are /oʊ/ and /aɪ/, /aɪ/ and /ə/, and /əɹ/ and /aɪ/ which are expected to alternate 33 times, but do not alternate at all.

(16) German Uncommon Vowel Alternations

Vowel 1	Vowel 2	Observed	Expected	O/E Value
aɪ	i	4	71.1	0.06
aɪ	ɪ	3	61.2	0.05
eɪ	aɪ	4	65.16	0.06
aɪ	ɛ	2	43.61	0.05
i	ɛ	2	34.91	0.06
oʊ	aɪ	0	33.42	0
aɪ	ə	0	32.73	0
əɹ	aɪ	0	32.66	0

7.2.2.2. Consonant Alternations

(17) German Common Consonant Alternations

Cons. 1	Cons. 2	Observed	Expected	O/E Value
n	m	119	40.99	2.9
t	d	115	50.74	2.27
s	z	62	34.54	1.79
ŋ	n	44	33.46	1.31
n	l	43	68.69	0.63

The most common consonant alternations are /n/ and /m/, which alternate 116 times in stressed syllables, and 3 times in unstressed syllables. The expected ratio for this alternation is only 42 times. Other common alternations are /t/ and /d/, which alternate 114 times in stressed syllables, and once in unstressed syllables, with the expected ratio of 51 times. /s/ and /z/, which alternate 61 times in stressed syllables,

and once in unstressed syllables, with the expected ratio of 34 times. /ŋ/ and /n/, which alternated 35 times in stressed syllables, and 9 times in unstressed syllables, with the expected ratio of 33 times.

Interestingly uncommon alternations include the consonants /n/ and /d/, which are the most common consonants in the corpus. Those include /n/ and /d/ which are expected to alternate 98 times, but only do 5 times. /z/ and /n/ which are expected to alternate 88 times, but only do 9 times. /t/ and /n/ are expected to alternate 84 times, but only do 13 times. /s/ and /n/ are expected to alternate 64 times, but only do 5 times. /l/ and /d/ are expected to alternate 36 times, but only do 5 times. /m/ and /d/ are expected to alternate 41 times, but only do 8 times. /z/ and /t/ are expected to alternate 46 times, but only do 16 times. Interesting to mention pairs that do alternate in a large amount, but significantly fewer than expected such as /n/ and /l/ are expected to alternate 69 times, but only do 43 times. /z/ and /d/, which are expected to alternate 53 times but only do 25 times.

(18) German Uncommon Consonant Alternations

Cons. 1	**Cons. 2**	**Observed**	**Expected**	**O/E Value**
n	d	5	98.27	0.05
z	n	9	88.3	0.1
t	n	13	84.09	0.15
s	n	5	63.7	0.08
n	l	43	68.69	0.63
z	d	25	53.28	0.47
m	d	8	41.45	0.19
z	t	16	45.59	0.35

The full data of alternations and expected ratio is available in Appendix C.

7.3. English Results

In the created corpus, English speakers resulted in 3,359 pairs of rhymes. 1,643 of which are by American English speakers, and additional 1,716 by British English speakers. In the following chapter, I will be focusing on commonalities between the two dialects. The relevant appendixes include the full data from both dialects. Out of these, 1,407 are perfect, resulting in 58% (1,952) pairs of imperfect rhymes. Of these, 1228 (63%) include at least one consonant or vowel deletion.

Of the imperfect rhyming pairs, 846 (43%) include at least one alternation in consonants. 590 (30%) include at least one alternation in vowels. 1,185 (61%) include an alternation in a stressed syllable of the rhyme, while only 80 (4%) include an alteration in an unstressed syllable. Most rhyming pairs include more than one alteration or deletion.

Most changes in consonants occur in coda position, while only 5% of alternations and deletions occur in onset position. In the following sections, the onsets were omitted from the calculations and the numbers of both existing consonants in the corpus and changes between rhyming pairs address only consonants in coda positions.

7.3.1. Deletions

7.3.1.1. Vowel Deletions

Over all, 25 stressed vowels were deleted, and an additional 77 unstressed vowels were deleted. This makes a total of 102 vowels, out of 7,935 vowels in the corpus, about 1%. The most frequently deleted vowel is the reduced vowel /ə/, mostly in its appearance with the following /ɹ/ - /əɹ/. /əɹ/ was deleted 45 in an unstressed position to a total of 10.5% of its appearances. In addition, /ə/ was deleted 19 times in an unstressed position to a total of 5% of its appearances.

An interesting deletion is that of the vowel /ɪ/ which is deleted 10 times in an unstressed position to a total of 1% of its appearances. Other interesting cases include /ɑɹ/ which is deleted 2 times in a stressed position also to a total of 2% of its appearances. /eɪ/ is deleted 8 times in a stressed position, in 0.7% of its appearances. /i/, which is deleted 4 times in a stressed position and once more in an unstressed position, to a total of 0.4% of its appearances. Other deleted vowels were only deleted in a very low amount, and higher percentages are caused due to a low number of appearances.

(19) English Vowel Deletions

Stressed vowel deletions		**Unstressed vowel deletions**	**Total Deletions**	**Total Vowel appearance**	Percentage out of vowel's appearances
əɹ	0	45	45	430	10.5%
ə	0	19	19	344	5.5%
ʊ	1	0	1	26	4%
ɔ	1	0	1	229	4%
ɑɹ	2	0	2	84	2%
ɪ	0	10	10	816	1%
ɛɹ	2	0	2	147	1%
ɔɹ	2	0	2	161	1%
u	1	1	2	255	0.8%
eɪ	8	0	8	1,089	0.7%
oʊ	2	1	3	467	0.6%
i	4	1	5	1,064	0.4%
aɪ	2	0	2	1,187	0.2%
Undeleted vowels		ɒ, ɛ, ʌ, æ, aʊ, ɔɪ		1,636	0%
Sum	25	77	102	7,935	1%

Generally vowels are deleted in the corpus in cases of hiatus as in the given examples. Out of 102 vowels deleted, 60% (61) are deleted in a case of hiatus, and 40% (41) are deleted without hiatus.

7.3.1.2. Consonant Deletions

(20) English Consonant Deletions

Cons.	Stressed	Unstressed	Total Deletions	Total appearances	Percentage (of appearances)
z	329	26	365	828	44%
b	2	0	2	8	25%
d	247	10	257	1,035	25%
f	23	0	23	102	22.5%
ð	8	0	8	38	21%
v	45	1	46	224	20.5%
ʒ	1	0	1	6	17%
p	17	0	17	103	16.5%
k	34	1	35	238	15%
m	55	0	55	359	15%
s	73	6	79	569	14%
l	83	5	88	624	14%
t	83	8	91	686	13%
θ	11	0	11	94	12%
n	167	15	182	1,530	12%
ŋ	27	5	32	282	11%
g	2	0	2	19	10.5%
d͡ʒ	5	0	5	65	8%
t͡ʃ	1	0	1	22	4.5%
ʃ	0	1	1	27	4%
Undeleted Consonants			j, ɹ, w	26	0%
Sum	1,213	78	1,301	6,863	19%

A total of 1,213 consonants were deleted in stressed syllables, and an additional 78 consonants were deleted in unstressed syllables, to a total of 1,301 deleted consonants out of 6,863 consonants in the corpus, 19% deleted of all consonants. A few consonants are deleted in large numbers, and those can be divided into two major

groups - a morphological group of inflectional suffixes, and a phonological group of sonorant consonants, same as the case in the results of Hebrew and German speakers.

The four single consonants were deleted in high numbers and included 329 deletions of /z/ in stressed position and additional 26 in unstressed position to a total of 365 deletions, 44% of the consonant's appearance - the largest amount in both numeric and percentage values, same as in Hebrew and German. Only 30 deletions (8% out of /z/ deletions) occurred in cases of which /z/ did not act as a suffix.

247 deletions of /d/ in stressed position and additional 10 in unstressed position to a total of 25% of occurrences. In this case, 172 cases of the deletions (67%) did not involve a suffix. 73 deletions of /s/ in stressed position and additional 6 in unstressed position to a total of 14% of occurrences, 41 of those (52%) did not involve a suffix. 83 deletions of /t/ in stressed position and additional 8 in unstressed position to a total of 13% of occurrences, of which 83 (91%) did not involve a suffix. The division of those deleted consonants is similar to that in the results of Hebrew and German.

Another interesting group is the phonological group of sonorant consonants, which include /l/, /n/, /m/, and /ŋ/, and exclude /ɹ/ due to the low number of appearances. This group includes 167 deletions of /n/ in stressed position and additional 15 in unstressed position to a total of 11% of occurrences, 83 deletions of /l/ in stressed position and additional 5 in unstressed position to a total of 14% of occurrences, 55 deletions of /m/ in stressed position to a total of 15% of occurrences, and 27 deletions of /ŋ/ in stressed position and additional 5 in unstressed position to a total of 11% of occurrences.

A few consonants are worth mentioning - /v/, was deleted 46 times in a stressed position and additional once in unstressed position to a total of 20.5% of occurrences,

and /f/ was deleted 23 times in a stressed position to a total of 22.5% of occurrences, a larger percent than was shown in Hebrew and German. /b/ was deleted twice in a stressed position to a total of 25% of occurrences. /ð/ was deleted 8 times in a stressed position to a total of 21% of appearances. /ʒ/ was deleted once in a stressed position to a total of 17% of appearances. This high percentage is caused by the low number of appearances in the corpus, which occurs in all languages.

The full data of deletions divided by speakers of EN-US and EN-UK is available in Appendix E.

In very few cases, an entire syllable was deleted. This happens 47 times in the entire corpus, meaning, 0.02% of rhymes include a syllable deletion. 30 of the cases occur in stressed syllables, and only 17 of the cases occur in unstressed syllables.

Clusters occur in coda position, in at least one of the words in a rhyming pair, in 29% of the rhymes and in 41% of imperfect rhymes. Only in 31 cases (4%), the cluster was kept and the changes which caused imperfection were in another segment such as the preceding vowel, a coda of another syllable etc. In 11% of the cases (86), imperfection was caused due to a consonant change, and not deletion.

In 90 (11%) of the cases, the entire cluster was deleted. In 590 cases (73%) a part of the cluster was deleted. In most cases, 409 (70% of clusters in which some of the segments were deleted), the end of the cluster was deleted. In 174 cases (29%), the beginning of the cluster was deleted. In a few single cases, the deletion occurred either in the middle - C2 deleted while C1+C3 are kept (7 cases, 1%), or at both edges - C1+C3 are deleted while C2 is kept (7 cases, >1%).

The same observation that was made in Hebrew and German results applies here as well - different segments are deleted in different positions of the cluster. There appears to be a preference for sonorant consonants to be deleted at the beginning of the cluster, while obstruents are mostly deleted at the end of the cluster which is the less prominent position. For example, /n/ was deleted 80 times at the beginning of a cluster but only once at the end, and /l/ was deleted 29 times at the end of a cluster but only twice at the end. On the other hand, /d/ was deleted 154 times at the end of a cluster but only 11 times in the beginning, and /z/ was deleted 176 times at the end, but only 5 times at the end of a cluster.

7.3.2. Alternations

Alternation was marked when there was a corresponding segment in both words of the rhyming pair, but those segments are not identical. The formula for O/E values was presented in previous result sections.

7.3.2.1. Vowel Alternations

A large majority of the alternating vowels included an alternation between vowels bearing primary stress. Only in 8% of the alternations (46 cases) an alternation was made between primary and secondary secondary stress, and in 2 cases only (>1%), an alternation was made between two vowels bearing secondary stress.

(21) English Common Vowel Alternations

Vowel 1	**Vowel 2**	**Observed**	**Expected**	**O/E Value**
ɪ	i	67	54.71	1.22
eɪ	ɛ	44	41.52	1.06
ɪ	ə	30	17.69	1.70
ʌ	ɔ	26	4.73	5.49
ɪ	ɛ	26	31.11	0.84
æ	ɛ	22	12.81	1.72

The most common vowel alternations are /ɪ/ and /i/, which alternate 62 times in stressed syllables and additional 5 times in an unstressed syllable. The expected ratio for this alternation is 55 times. Other common alterations are the diphthong /eɪ/ and /ɛ/, which alternate 44 times in stressed syllables, with the expected ratio of 41 time. /ɪ/ and /ə/, which alternated once in a stressed syllable and 29 times in unstressed syllables, with the expected ratio of 18 times, /ʌ/ and /ɔ/ which alternate 26 times in stressed syllables with the expected ratio of 5.5 times. /æ/ and /ɛ/ which alternate 22 times in stressed syllables with the expected ratio of twice. Other mentionable alternations are /ɪ/ and /ɛ/ which alternate 26 times in stressed syllables with the expected ratio of 31 times.

(22) English Uncommon Vowel Alternations

Vowel 1	**Vowel 2**	**Observed**	**Expected**	**O/E Value**
eɪ	aɪ	5	81.45	0.06
aɪ	i	3	79.58	0.04
eɪ	i	10	73.01	0.14
aɪ	ɪ	3	61.03	0.05
eɪ	ɪ	11	55.99	0.20
aɪ	ɛ	3	45.25	0.07

Interestingly uncommon alterations include the vowels /aɪ/ and /eɪ/ which are expected to alternate 81 times, but only do so 5 times. /aɪ/ and /i/ are expected to alternate 80 times, but only do 3 times. /eɪ/ and /i/ are expected to alternate 73 times, but only do 10 times. /aɪ/ and /ɪ/ are expected to alternate 61 times, but only do 3 times. /eɪ/ and /ɪ/ are expected to alternate 56 times, but only do 11 times. /aɪ/ and /ɛ/ which are expected to alternate 45 times, but only do so 3 times.

6.3.2.2. Consonant Alternations

(23) English Common Consonant Alternations

Cons. 1	Cons. 2	Observed	Expected	O/E Value
n	m	125	40.02	3.12
t	d	60	51.73	1.16
z	d	45	62.43	0.72
n	l	43	69.56	0.62
z	s	41	34.32	1.19

The most common consonant alternations are /n/ and /m/, which alternate 122 times in stressed syllables, and 3 times in unstressed syllables. The expected ratio for this alternation is only 40 times. Other common alternations are /t/ and /d/, which alternate 55 times in stressed syllables, and 5 times in unstressed syllables, with the expected ratio of 52 times. /s/ and /z/, which alternate 36 times in stressed syllables, and 5 times in unstressed syllables, with the expected ratio of 34 times. Other mentionable alternations are /z/ and /d/, which alternated 45 times in stressed syllables, with the expected ratio of 63 times, and /n/ and /l/, which alternated 40 times in stressed syllables and additional 3 times in unstressed syllables, with the expected ratio of 70 times.

(24) English Uncommon Consonant Alternations

Cons. 1	Cons. 2	Observed	Expected	O/E Value
n	d	25	115.37	0.22
z	n	9	92.29	0.10
t	n	11	76.47	0.14
s	n	18	63.42	0.28

Interestingly uncommon alternations include the consonants /n/ and /d/, which are the most common consonants in the corpus, similar to German and Hebrew results. Those include /n/ and /d/ which are expected to alternate 115 times, but only

do 25 times. /z/ and /n/ which are expected to alternate 92 times, but only do 9 times. /t/ and /n/ are expected to alternate 76.5 times, but only do 11 times. /s/ and /n/ are expected to alternate 63 times, but only do 18 times.

The full data of alternations and expected ratio is available in Appendix D.

7.4. Language Comparison

7.4.1. Methodology for Statistical Comparison

In the following section, I will present the comparison between the three languages using various statistical examinations. The association between the group characteristic (independent variable) and the patterns of non-perfect rhyme (dependent variable) was first examined using a Chi-Square (χ^2) Test of Independence on the contingency table of observed segment changes across the three groups.

To pinpoint the specific sources of the overall significant association, a secondary analysis was performed using Standardized Residuals (Agresti, 2013). Each cell's standardized residual was calculated, indicating the extent to which the observed frequency deviated from the frequency expected under the null hypothesis of independence. A standardized residual with an absolute value of $|Z| \geq 1.96$ was considered statistically significant at the $\alpha=0.05$ level, indicating that the specific pairing of a group and a phonological change occurred significantly more or less often than expected. In data tables presented in the following sections, greyed out cells indicate Z value is not statistically significant.

In the following section, I will focus on the most interesting results i.e. results that were described as main deletions and alternations in the following sections, and their relations to other languages. §6.4.2 will focus on deletions and will examine

whether the pattern of deletions varies between languages. §6.4.3 will focus on alternations including vowel alternations (§6.4.3.1), consonant alternations (§6.4.3.2) including feature alternations.

I will determine, using statistical tools, whether differences indicate language-specific patterns or universals. A statistically significant difference between languages is suspected as a language specific result. Results that are similar between languages are suspected as universals. A full discussion of the results is presented in §7.

7.4.2. Deletions

7.4.2.1. Vowel Deletions

A Chi-Square test was done to all the vowels deleted in the corpus by the speakers of the three languages. A Chi-sqaure test showed there is no statistically significant difference between the general rate of vowel deletions, as opposed to vowels in rhyme position that were not deleted (a 3x2 contingency table), $\chi^2(2)=1.759$, $p=0.415$ (N=21,245).

The Chi-Square test assumes that the expected frequencies (E) in all cells are $E\geq1$. It is further recommended that at least 80% of the cells have an expected count of $E\geq5$. For that reason, some of the vowels were omitted for having either 0 observed deletions in at least one language (/ɛ/, /u/, /aɪ/, /oʊ/, /ɑɹ/, /ɜɹ/, /ɔɹ/, /ɔɪ/, /ɛɹ/) or only 1 observed deletion in all languages (/ɔ/, /ʊ/).

A Chi-Square test of the vowels showed no statistically significant difference between the three languages in a deletion of vowels, (a 3x5 contingency table), $\chi^2(8)=12.302$, $p=0.138$ (N=210). According to the examination, all languages delete each vowel in relatively similar amounts.

7.4.2.2. Consonant Deletions

In the case of consonant deletions, there are significant differences between the deletions of consonants in the different languages. A Chi-sqaure test showed a statistically significant difference between the general rate of consonant deletions, as opposed to consonants in rhyme position that were not deleted (a 3x2 contingency table), $\chi^2(2)=112.8575$, $p<0.001$ (N=19,036). Standardized residual showed that English speakers tend to delete more consonants than expected ($Z_{(EN)}=10.42$), while Hebrew and German speakers delete fewer consonants than expected ($Z_{(DE)}=-3.992$, $Z_{(HE)}=-6.827$)

An additional Chi-Square test examined the difference between deleted consonants. In this case as well, consonants were omitted for having 0 observed deletions in at least one language (/b/, /ð/, /j/, /ɹ/, /tʃ/, /ʃ/, /w/, /ʒ/). This resulted in a 3x15 contingency table. $\chi^2(28)=48.862$, $p=0.014$ (N=2880). Since $p<0.05$, there is a significant difference between the languages in 95% accuracy ($\alpha=0.05$).

(25) Standardized Residual for Consonant Deletion

Deleted consonant	**HE**		**DE**		**EN**	
	Z	**Description**	**Z**	**Description**	**Z**	**Description**
n	2.731	**Higher**	-1.164	Lower	-1.249	Lower
ŋ	0.062	Higher	-2.368	**Lower**	2.159	**Higher**
s	2.225	**Higher**	1.215	Higher	-3.038	**Lower**
t	-0.721	Lower	2.685	**Higher**	-1.891	Lower
g	2.081	**Higher**	-0.981	Lower	-0.863	Lower

Z value is statistically significant when $|Z| \geq 1.96$.

A standardized residual test was made for all consonant deletions. Table 25 shows all consonants with SR rate that affects the difference between observed and

expected rates. It is important to mention that the consonant /g/ was deleted at a low rate (8 times total).

Suffixes

Additional Chi-Square tests were made to examine whether there is a significant difference between the deletion of a consonant as a suffix in opposed to non-suffix. In all cases, there was no significant difference between the languages. Meaning, the speakers of all languages prefer to delete a consonant in its appearance as a suffix or without. The consonants /s/ and /z/ were preferred to be deleted as a suffix while /t/ and /d/ were preferred to be deleted as non-suffix. All of the preferences are statistically significant, except for /s/:

(26) Significance of Suffix Deletion

Consonant	**P**	**χ^2**	**Preferred deletion**	**Significance**
d	>0.001	72.45	Non-suffix	Significant
t	>0.001	124.52	Non-suffix	Significant
s	0.101	2.692	Suffix	Not significant
z	>0.001	484.12	Suffix	Significant

7.4.3. Alternations

In the following section, I examine all segments that alternate a large number of times (over 30) in at least one language. This decision was made for convenience, in order to focus the discussion on results. For specific pairs of segments, all examinations were made in a 2x3 contingency table. Further examination of the results was made for specific consonantal features - voice, place of articulation and manner of articulation. Those will be detailed below.

7.4.3.1. Vowel Alternations

(27) χ^2 Results of Alternating Vowel Pairs

Alternating Vowels	χ^2	**P**	**Description**
/eɪ/-/ɛ/	0.708	0.702	No significant difference between languages
/æ/-/ɛ/	21.222	>0.001	A significant difference between languages
/oʊ/-/ɔ/	18.238	>0.001	A significant difference between languages
/ʌ/-/ɔ/	9.165	0.01	A significant difference between languages
/ɪ/-/i/	6.413	0.405	A significant difference between languages, P value is close to the cutoff point.

Table 27 details χ^2 results for alternation of vowel pairs. In all cases, Table 27 details χ^2 test was made with 2 DF, a contingency table of 2x3, N=1849. Table 28 provides SR results for pairs with a significant difference.

(28) Standardized Residual for Consonant Deletion

Alternating Vowels	**HE**		**DE**		**EN**	
	Z	**Description**	**Z**	**Description**	**Z**	**Description**
/æ/-/ɛ/	1.79	Higher	2.803	**Higher**	-4.563	**Lower**
/oʊ/-/ɔ/	4.177	**Higher**	-1.293	Lower	-2.902	**Lower**
/ʌ/-/ɔ/	-2.554	**Lower**	2.676	**Higher**	-0.089	Lower
/ɪ/-/i/	2.017	**Higher**	-2.329	**Lower**	-0.283	Lower

7.4.3.2. Consonant Alternations

Table 29 details χ^2 results for alternation of vowel pairs. In all cases, the χ^2 test was made with 2 DF, a contingency table of 2x3, N=2261. Table 30 provides SR results for pairs with a significant difference.

(29) χ^2 Results of Alternating Consonant Pairs

Alternating Vowels	χ^2	**P**	**Description**
/n/-/m/	0.254	0.88	No significant difference between languages
/n/-/l/	0.356	0.837	No significant difference between languages
/z/-/d/	4.764	0.092	No significant difference between languages
/t/-/d/	32.45	>0.001	A significant difference between languages
/s/-/z/	6.013	0.494	A significant difference between languages, P value is close to the cutoff point.
/ŋ/-/n/	6.928	0.031	A significant difference between languages

(30) Standardized Residual for Consonant Alternation

Alternating Vowels	**HE**		**DE**		**EN**	
	Z	**Description**	**Z**	**Description**	**Z**	**Description**
/t/-/d/	-2.696	**Lower**	5.689	**Higher**	-3.27	**Lower**
/s/-/z/	0.277	Higher	2.083	**Higher**	-2.301	**Lower**
/ŋ/-/n/	0.309	Higher	2.494	**Higher**	-2.196	**Lower**

Feature Comparison

An additional analysis was made to examine whether different language speakers demonstrated a preference for alternating pairs of specific features.

Voicing was examined in a 3x3 contingency table, including pairs of a voiced consonant with a voiced consonant, voiceless with voiceless and voiced with voiceless. A significant difference between languages was determined. $\chi^2(4)=24.388$, $p<0.001$ (N=2261). Table 31 shows the results in every pair.

(31) Standardized Residual for Voicing Alternation

Alternating Voicing Feature	HE		DE		EN	
	Z	**Description**	**Z**	**Description**	**Z**	**Description**
Voiced + Voiced	2.742	**Higher**	-3.959	**Lower**	1.16	Higher
Voiceless + Voiceless	-0.905	Lower	-1.316	Lower	2.901	**Higher**
Voiced + Voiceless	-2.194	**Lower**	4.597	**Higher**	-2.628	**Lower**

Manner of articulation included a more complex contingency table, built by the metric presented in table 32. Greyed out cells in the metric included a value of 0 in at least one language and thus were combined to the category "Other". This category includes all alternations of either an Approximate consonant or an affricate consonant, excluding alternations with stops or fricatives.

(32) Manner of articulation Chi-Square Metric

Affricate+Affricate					
Affricate+Approx	Approx+Approx				
Affricate+Fricative	Approx+Fricative	Fricative+Fricative			
Affricate+Lateral	Approx+Lateral	Fricative+Lateral			
Affricate+Nasal	Approx+Nasal	Fricative+Nasal	Lateral+Nasal	Nasal+Nasal	
Affricate+Stop	Approx+Stop	Fricative+Stop	Lateral+Stop	Nasal+Stop	Stop+Stop

Manner of articulation was examined in a 3x12 contingency table, A significant difference between languages was determined. $\chi^2(22)=85.84$, $p<0.001$ (N=2261). In this case, no language showed preference for most pairs of manners. The following mentions are of pairs with a significant preference.

(33) Standardized Residual for Manner Alternation

Alternating Manner Feature	HE		DE		EN	
	Z	**Description**	**Z**	**Description**	**Z**	**Description**
Stop + Stop	-2.819	**Lower**	4.761	**Higher**	-2.247	**Lower**
Affricate + Fricative	-3.236	**Lower**	-0.299	Lower	3.399	**Higher**
Fricative + Fricative	-0.2	Lower	-2.78	**Lower**	-2.573	**Lower**
Nasal + Fricative	0.927	Higher	-4.295	**Lower**	3.467	**Higher**
Stop + Fricative	0.391	Higher	-3.406	**Lower**	3.025	**Higher**

Place of articulation was tested in groups of labial, coronal and dorsal consonants, in a contingency table of 3x5. A combination of a dorsal consonant and another dorsal consonant was omitted, since in one of the languages no such alternation occurred. In this case, no significant difference was found between different language speakers. $\chi^2(8)=8.94$, $p=0.347$ ($N=2258$).

Chapter 8. Discussion

8.1. General Discussion

An examination of the three languages shows similarities and differences in the results. Results demonstrating the same similarity patterns, may indicate universals. In this case, it is expected for speakers of all languages to provide similar choices. I will not get into the discussion whether such universals are grounded or innate. Results that differ between languages, could indicate language specific patterns, in which elements of L1 such as phonological processes, distinctive features or even phonemes affect L2.

8.1.1. Potential Universals

8.1.1.1. Vowel Deletion

The deletion of a vowel is crucial for the prosodic structure of the rhyme, more than consonant deletion. A deletion of a vowel not only affects the CV structure of the syllables, like a consonant, but it is almost bound to affect the number of syllables as well, as well as the possibility of changing the rhythm of the rhyme itself.

There is no statistically significant difference in the rate of vowel deletions between the languages. It is noticeable that English speakers had a slight preference for deletion of vowels, while L2 speakers showed a slight preference to avoid vowel deletion. This is not statistically significant, but a small indication of the confidence of speakers in the language, i.e. native speakers of a language feel more free to conduct changes that affect the prosody of the language as those have proper solutions derived from their linguistic knowledge to deal with said problem, while non-native speakers tend to produce forms closer to the phonemic and orthographic forms of the words.

In the specific vowels deleted, there was no significant difference between the deleted vowels themselves. It is possible to deduce a universal preference for deletion of vowels that are less prominent, as discussed by Kenstowicz (2007), which discusses the preference to delete a less salient vowel. Those are often unstressed, short, lax, and often lack their own inherent features. Those include the reduced or epenthetic vowel /ə/, necessarily unstressed in English, which while causing a change in prosody, its deletion is not a major change such as a stress bearing vowel. In addition, is its appearance with the following /ɹ/, which can also appear as a suffix, in which cases the prosody is least affected. /əɹ/ is the vowel with the highest deletion rate, with 106 deletions overall.

Other vowels which are preferably deleted in all languages are the high, front vowels - /i/ and /ɪ/, differing by length and ATR. Those vowels are stated here to be less prominent for speakers of all languages, as a suspected universal. Given that in general high vowels are shorter than lower vowels (Lehiste, 1970), and the difference between short vowel and zero is smaller than that of long vowel and zero (Kenstowicz, 2007), explains the data and provides a strong claim for said universal.

8.1.1.2. Consonant Deletion

While Chi-Square tests showed a significant difference between the preference of each language to perform deletions of consonants, it is again noticeable that English speakers delete consonants more frequently than Hebrew and German speakers. The effect on prosody in deletion of consonants is less than in deletion of vowels, once again the effect of confidence in the clarity of chosen rhymes.

In addition, according to the statistical testing of the results, some of the consonants are deleted at a similar rate between the three languages, those are - /d/,

/dʒ/, /f/, /k/, /l/, /m/, /p/, /v/, /z/, /θ/. The deletion of these consonants is a suspected universal, as it is similar in all tested languages.

As discussed in each language's clusters, all languages prefer to delete sonorant consonants in the beginning of a cluster and obstruents at the end of a cluster. This is also a suspected universal, but since the research did not focus on the deletion patterns in clusters, it will require further research.

Suffix Deletion

The matter of suffix deletion was discussed by Zwicky (1976), and a further examination of the matter was done in this research. The data did show that all languages prefer to delete the relevant consonants (/s/, /z/, /t/, /d/) similarly either in their occurrence as a suffix or as a non-suffix, i.e. language of origin does not affect the preference to delete a consonant in its occurrence as a suffix or as non-suffix.

The difference occurs between the type of suffix. /z/ is significantly preferred to be deleted in their occurrence as either a plurality suffix, or less commonly in the data - possession and 3rd person present. For /s/, there is an insignificant tendency for a deletion as a suffix, as opposed to non-suffix. The data in this case support Zwicky's claim that the omission of such highly used suffixes and the ability to understand them from context is the cause of such a high rate of deletions.

However, for /d/ and /t/, there is a significant preference for deletion in cases where the consonants appear not as the inflectional suffix of past tense verbs. This might indicate that the appearance of /d/ and /t/ as a suffix is different then that of /z/. Past tense suffixes are rarer and cannot necessarily be indicated from context, thus it seems speakers prefer to avoid their deletion, meaning that the high rate of deletion in this case is not derived from the claim made for suffixes but from something else.

The high rate of deletions which is similar in all languages for /d/ might occur due to the high rate of appearances of the consonants in general in the corpus. This correlates to a discussion made by Coetzee (2008), which claims that the rates of deletion of /d/ and /t/ can be directly correlated to their high frequency in the language, in any case such deletion is made possible by other grammatical rules of the language.

It is important to note that knowledge of suffixes is learned, and that knowledge is similar between speakers of L1 and L2. However, it is not phonological knowledge but metalinguistic knowledge which is more explicit and therefore more accessible to all language speakers. Given that, it is expected that rates of deletions of suffixes will be similar between different language speakers, in contrast to more implicit phonological knowledge which can differ between languages.

8.1.1.3. Consonant Alternations

In three cases, alternations between consonants showed significant similarity, i.e. no significant difference between languages. Those include the cases of /n/-/m/ and /n/-/l/. Those are expected as the general similarity between sonorant consonants is greater than between obstruent consonants, as discussed by many including Steriade (2008).

This similarity indicates a universal - sonorant consonants are more similar to one another than obstruents are. Their alternations might be less noticeable, and thus more frequent, than obstruents. In cases the consonants are not common in the corpus (/ŋ/ and /ɹ/), their prominence remains and those are not alternating quite as frequently.

Another interesting alternation, that is similar in all three languages, is that of /d/-/z/. Those are the most frequent consonants in all languages, aside from /n/. Those consonants also differ only in manner of articulation. That might indicate that frequent consonants are universally more similar than infrequent consonants, A discussion about manner of articulation is detailed below.

In the case of featural comparison, place of articulation did not show a significant difference between the languages at all. This indicates that the perceived similarity between two places of articulation is either universal or at least common to the three discussed languages. In this specific case, all three languages of this research share almost all the same places of articulation. This is one of the limitations of the current study that can be addressed in a further study.

In the case of manner of articulation, some of the combinations of manners did not pose a significant contribution to the significant difference between languages, meaning, the commonality of those combinations is universal. These include a combination of a nasal consonant and a stop, a lateral and another nasal, a stop with a lateral and an affricate and a fricative and a stop.

Another interesting observation is that all languages tend to avoid an alternation of two fricatives. Even though this preference is significant in English and German and existing but not significant in Hebrew, it nevertheless exists in all languages. This is a strong indication that for fricatives, place of articulation and vocicing are a lot more prominent in rhyme position than manner, in all languages. Namely, the distinction among fricatives is more perceptible, and therefore they are less interchangeable. The distinction between nasal, sonorants, stops etc. is less perceptible, and therefore they are more interchangeable.

8.1.2. Suspected Language Specifics

8.1.2.1. Vowel Alternation

For vowel alternation, the results clearly indicate that in any case there is a significant difference between the languages, English speakers will always avoid the alternation, while Hebrew and German speakers prefer it. The only case Hebrew speakers also avoided the alternation while German speakers preferred it is the case of /ʌ/-/ɔ/, which differ in backness. Backness in vowels is a distinctive feature in Hebrew, which does not distinguish in length/ATR, and only has 3 degrees of height as opposed to English and German's 4.

Hebrew speakers preferred alternating vowels differing in length and/or ATR, two non-distinctive features in Hebrew as mentioned, /æ/-/ɛ/ and /ɪ/-/i/, in addition to the very close diphthong and vowel /oʊ/-/ɔ/. The interesting comparison here is that German speakers tended to avoid the combinations of /ɪ/-/i/ and /oʊ/-/ɔ/, of vowels that exist in their language, they did tend to prefer the alternation of /ʌ/-/ɔ/ and /æ/-/ɛ/ - in which at least one vowel does not exist in their L1.

8.1.2.2. Consonant Alternation

In terms of featural testing, the most interesting case is that of voicing. The pairing of a voiced and a voiceless consonant alternating in rhyme position is significantly higher in German, and significantly lower in English and Hebrew. While for English and Hebrew speakers, voiced and voiceless consonants contrast in all prosodic positions, German speakers do not contrast voicing in coda position, which is the relevant position for rhyming. Moreover, the combination of two voiced consonants in rhyme position is significantly unwanted for German speakers. This is a strong indication that final devoicing in German is not only highly effective, but also has an effect on L2 even though it does not exist in the discussed L2.

It is worth noting that while Hebrew speakers distinctly prefer the rhyming of two voiced consonants, English speakers prefer the rhyming of two voiceless consonants. This preference is significant, and shows a slight preference for prominence in rhyme position. Hebrew speakers attach higher importance to voicelessness while English speakers attribute it to voiced consonants. Nevertheless, it is clear that the distinction in voice is prominent for speakers of languages without final devoicing, and less so for German speakers.

In the case of manner of articulation, there are a few interesting distinctions. For the alternation of a stop with another stop, German speakers significantly prefer the alternation while English and Hebrew speakers significantly prefer to avoid the alternation. While the voice feature in word final position plays a role in English and Hebrew and not in German, this can actually be an expected result. Assuming place is of similar prominence for all languages, as the data suggest, the similarity of two stops is a lot higher for German speakers who do not attribute significance to voice than that of English and Hebrew speakers who do - making two stops of different voice, for example, considerably more different.

In the absence of distinction in voice, and similarity of distinction in place, the distinction of manner is of more importance to German speakers than English and Hebrew. This is demonstrated alternation between a stop and a fricative, which is significantly preferred by English speakers and preferred by Hebrew speakers (not significantly), but significantly avoided by German speakers. This is also the case in all alternations that affect the difference between languages, stop with a stop, as described above.

In the case of a combination between a stop and a fricative it is possible to assume Hebrew speakers would tend to prefer the combination as opposed to other languages, because of the spirantization process. However, the preference, while existent, is not significant. This is interesting because the process of spirantization is dormant and less active in contemporary Hebrew, such as that spoken by the examined songwriters.

8.1.3. General Conclusions

The given conclusions of the study show that there is a possibility to map universals as opposed to language specific in similarity patterns. The results clearly state that some elements of the spoken language are universal, such as similarity in sonorant consonants and consonants with high frequency. On the other hand, in case of a strong linguistic process, such as final devoicing in German, it crosses to L2 and affects not only the produced language but also the perceived one.

English speakers avoided alternations of phonemic differences. For speakers of English as L2, in this case Hebrew and German, if these differences are not phonemic in L1 the segments are considered *more similar* and thus are alternating more frequently.

The data regarding vowels show that both distinctive features and phonemic status of a vowel can have an effect on the speaker's perception of it in L2. When all distinctive features in L2 are also distinctive in L1, like in German vowels, speakers will perceive pairs including at least one vowel that is not phonemic in L1, as more similar. In case some distinctive features in L2 are not distinctive in L1, like in Hebrew, speakers will perceive pairs distinct by features that are not distinctive in L1 as more similar.

From all the data presented, I conclude that in general, similarity patterns are universal, but can be highly influenced by strong attributes of the origin language. Those attributes can include but are not limited to strong phonological processes, distinctive features and phonemic status of segments.

8.2. The Implications of the Study

This study shows, using patterns of similarity, that some of the features of our languages are universal and will universally exist in L2, while others are language specific and will affect speakers' use of L2 depending on their L1. In order to allow speakers to reach universality and proficiency in non-native languages, it is necessary to understand and be aware of the differences - mainly those which can affect the use of L2. Such an understanding is necessary to bridge these differences.

In any case that speakers wish to improve the usage of a second language, a speaker can map the problematic points which need to be addressed for major improvements. This is applicable not only in language teaching and professional training in language speaking and understanding, but also in the training and teaching of LLM and other AI models. Understanding the phonological differences across different L2 speakers and the factors influencing their perception of the target language is crucial for model improvement. By incorporating these variations, future language models can better accommodate L2 speech variation, leading to enhanced accuracy and general performance.

In the other direction, the study presented here is also an opening for methodologies not often used. The proof that strong and affective phonological processes in L1 affect L2 can be used as a tool. Testing of L2 can show the effectiveness of processes in L1. In addition, the study demonstrates the differences

between L1 and L2 in terms of confidence in the spoken language and willingness to make changes that might cause a greater effect, because of linguistic knowledge. Things like changes to prosody can be easier on L1 speakers, and more difficult for speakers of L2.

8.3. The Limitations of the Study and Further Research

The study brought here examined similarity patterns of three languages, two of them are in use of L2 and one as control in the use of L1. It examined segments in a specific syllable, word and phrase position. Further research can and should include more languages, with different segmental and featural inventories, and different phonological processes in different levels of effectivity.

The case of place of articulation demonstrates a limit on the testing of these specific 3 languages. In this case, all 3 languages share places of articulation and aside from dental consonants which do not exist in Hebrew and are not highly frequent in the data, all languages can have distinct consonants in the places of articulation available for English speakers. In this case, the data cannot determine whether the lack of distinction between languages was caused because of a universal or because of a point of similarity between the languages.

The idea of a P-Map, as described by Steriade (2008), claims that similarity and perceptibility are directly influenced by position. This study shows that in rhyme position, there is a difference between languages in some cases and similarity in others. This idea can and should be tested in other word positions. Additional studies such as described here can create, ultimately, a full P-map.

Chapter 9. Conclusion

This study examines the effect of L1 on perceived similarity in L2. This study focuses specifically on the rime position and examines speakers of English as L2 with Hebrew and German as L1, and speakers of English as a control group. The study uses a methodology of comparing rhyming patterns between the speakers of the languages in their lyrics writing in English, similar to the examination made by Zwicky (1976) and many thereafter.

This study includes a large corpus of rhymes written in lyrics of metal songs, and compares similar and different rhyming patterns. The hypothesis of this study is that similar rhyming patterns between speakers of all three languages is an indication of universal phonological patterns. On the other hand, different rhyming patterns show elements of L1 that have a strong effect on L2.

From the data, it was possible to show that some elements of L1 have a strong effect on L2. From those are noticeable - phonological processes such as final devoicing in German speakers, phonemic status of segments such as /ŋ/ that is not phonemic in Hebrew, and the availability of distinctive features such as differences in vowels. Other aspects suggest universality such as similarity between nasals, and sonorants in general, as well as highly frequent consonants.

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Appendices

Appendix A – List of Artists and Songs Used

Hebrew Speakers:

Singer	Band	Album	Song
Yotam ‘Defiler’ Avni	Prey For Nothing	Violence Devine	Cowardice; The Maw; Overture Of Dust; Breach; Dead Man's Dream; Tearing The Fabric; Averting Our Eyes; Bestowed Upon The Void; The Deadliest Rain; Violence Divine;
		Against All Good and Evil	Treachery; My Final Relapse; Unmake You; Buried By The Light; Chekhov's Gun; Deciphering The Signal; Home Made Holocaust; Turning Shears To Swords; Technocrat; Spiritual Guillotine; Against All Good; Against All Evil;
		The Reasoning	The Chemical Crusaders; The Reasoning; No Heir To The Throne; The Devil's Words (From The Angel's Mouth); Lost To The Flame; The Scale; Wolves In Wolves' Clothing; Sacred Evolution; Faith In Humanity - Destroyed; Shrouded Haven;
		Kivshan	Angels Of Atheism; The Sword Devours; Ocean of Tar; Each Other’s Throats; The Pinnacle - Part I: Peshat; The Pinnacle - Part II: Remez; The Pinnacle - Part III: Derash; The Pinnacle - Part IV: Sod
Shachar Bieber	Obsidian Tide	Debris	Mothman; Halfbreed; Debris
Oz Avneya		Pillars of Creation	Pillars of Creation; Seven; King of a New Realm; Portent of Betrayal; Hiraeth; The Harbinger and the Millennial Vengeance;
Aharon Ragoza	Shredhead	Human Nature	Magnanimous; Human Nature; Dead Eyes; Ruffies; Death Row; Becoming The Animal; Blood On Thy Hands; Knife In A Gun Fight; New Order; Rise; Zombies Attack;
		Death is Righteous	Devil's Race LPBZ; The Lie; Last Words Are Lost; Death Is Righteous; Hallucinations; Walk With The Dead; Can't Be Left Alive; Witness Hell; I Am
		Live Unholy	Live Unholy; Overshadows; King Maggot; Burn Your Master; Skin The Wolf; Unmarked; Create Hate; Fuck The World; Skin The Wolf; The Rope;
	Betzefer	Entertain Your	One Way To No Way; Dead Lines; Ain't No Party 'til You Hurt Somebody; Never Been;

		Force of Habit	Crash; Light Away; Truck Leaking Gasoline; Dying Man; Hand In Hand To Hell; The Last Song In The World;
Avital Tamir		Down Low	Early Grave; Down Low; Fuckin' Rock 'n' Roll; Under; Running Against; Brix; Mark; Split; 6's & 7's; Black Inside;
		Freedom to the Slave Makers	Best Seller; Backstage Blues; Feels So Right; Diamond Director; Nothing But Options; Empty Magazine; Doomsday; Perfect Life; Song for the Alcoholic; Haven Sent;
		The Devil Went Down to the Holy Land	The Devil Went Down to the Holy Land; Killing the Fuss; Cash; Yuppie Six Feet Underground; Copkiller; Sledgehammer; The Medic; Milk; Suicide Hotline Pt. 1; Suicide Hotline Pt. 2; Cannibal; I Hate; Can You Hear Me Now;
Ran Yerushalmi	Walkways	Safe in Sound	Blood Into Water; All Lies; Endless I; Towards the Light; Thoughts; Sweet Medicine; Out Actions; Skin Deep;
		Bleed Out, Heal Out	Till the End; Hell Born Shove (Impossible); Despair (For Heaven's Sake); Half the Man I Am; Trumpet Call; Levitate; Bleed Out, Heal Out; You Found Me; Unbearable Days; Humane Beings; Care (In This Together); Thank You; Bone Deep;
Oren Balbus	DPS	Ghosts	Haunted; Voices; Apparitions of the Dead; The Nothing; Connect the Realms in Turns; Errors of Our Ways; Rise and Fall; End of Days
Israel Papa	Unleash the Pain	Holes	The Runaway; Before The Edge; We're Not Gonna Make It; Spread The Red; Chronicles Of A Running Man; The Lure; Awakened; Resolution; Indigo; Bow; Circled Steps; It's Not A Fairytale
Aviv Hadari	Magor	Drawn to the Dark	Abject Humiliation; By Midnight; The Blackened Holocaust Stars; Essence To The Oblivion; Mania Depressia; The Reaper's Darkest Hours; Misanthropic Divine Supervision;
Yishai Sweartz	Tomorrow's Rain	Hollow	Trees; Fear; A Year I Would Like to Forget; In the Corner of a Dead End Street; Misery Rain; Into the Mouth of Madness; Hollow; The Weeping Song
Nadav Zaidman	Structural	Metacogni -tion	Fear of the Unknown; The Ceremony (Cut to the Point); Proteopathic; The Hunger Games; Turn On the Lights; We Will Stand As One; Selection of Blindness; Night Guardian; Apocalypse Has Begun;

		Decrowned	Your Damnation; My Grass Is Greener; And the Earth Has Rested; Utopia; White Lily; Purge of Sanity; Ascetic; Turbulence; Rebirth; Puppeteer
Adi Bitran	Orpheus Blade	Wolf's Cry	The Finest Art Of Feeding; The Becoming; Under Dying Stars; In Sickness and In Hell; The Death Of All Morrows; Dismissal; In Terms Of Twilight; Because He's Made Of Flesh; For Each Man Kills; Chronicles; Shapeshifter;
Noa Gruman	Scardust	Shadow	Tantibus; Shards - Pt I: Birds; Shards - Pt II: Shadow; Shards - Pt III: Gravity;
		Sands of Time	Overture (Sands Of Time Act I); Eyes Of Agony (Sands Of Time Act II); Dials (Sands Of Time Act III); Hourglass (Sands Of Time Act IV); Sands Of Time (Sands Of Time Act V); Arrowhead; Out Of Strong Came Sweetness; Queen Of Insanity; Blades; Gift Divine;
		Strangers	Overture for the Estranged; Break the Ice Tantibus II; Stranger; Concrete Cages; Over; Under; Huts; Gone; Addicted; Mist;
Uri Shalev	Dark Serpent	M.K.C	M.K.C.; Shot By Friendly Fire; Fully Charged With Hate; Locked In The Watchtower; Land Of Fear; Siatha De'Shmaya; Self Genocide; Defiance (Live); Enlightenment By Fire (Live); Fuck U (Live)
Ran Elihu	Matricide	When Random Turns to Fate	Further From The End; Wear & Tear; Not An Option; What Is Real?; Burn Me With Your Sun; Set To Clean; The Point Of No Return; Unreality; When Random Turns To Fate;
Ori Frank	Eternal Struggle	Year of the Gun	Point One; Year Of The Gun; As Heroes Fade; Indoctrination; On Broken Backs; Dependence; To My Enemies; Releechious; Modern Slave; Pride Kills; Last Path;
Leah Marki	Tillian	Reborn	Reborn; Touched; Frozen Sun; I'm too Close; Monster; Moonlight Dancer; Black Holes; The Beggar; Love or Heaven; Earth Walker;
Ben Saada	Canine	The Uprising	Silence Before Chaos; Mutiny; Last Words Live Forever; Reflection; From Ashes; To The Exile; With The Crows In Sight; The Uprising;
Davidavi "Vidi" Dolev	Subterranean Masquerade	Mountain Fever	Snake Charmer; Diaspora, My Love; Mountain Fever; Inwards; Somewhere I Sadly Belong; The Stillnox Oratory; Ascend; For the Leader, with Strings Music; Mångata;
	OMB	Swine Song	Milosh Had Seen Better Days; These Walls…; An Ordinary Caveman Sings Ode to; Obsession; Mother Gazelle Father Horse; Someday My Prince Will Come; A Smaller

			Dose of Tyranny; Undergrowth; Oh Mrs. Wade! You Shouldn't Have!; The Cricket's Broken Violin
Alon Karnieli	Sinnery	A Feast of Fools	H.A.C; Built to Kill; Magic Bullet; Showing Teeth; Mad Dog; Holy Ground; Black Widow; Symphony of Sorrow; A Feast of Fools
		Black Bile	The Burning; Black Bile; Who Will Be Eaten First; Sever; Anti Tribe; Mouthful of Nails; Hanged from the Sun; Bleak; Here Below; Holes
Yael Horowitz Ofer Friedman	Stormbound	December	Desert's Roar; Altar of Innocence; Sacred Lies; Away From Here; December; Shadows; Flying High; Fragments; Child's Play;

German Speakers:

Singer	**Band**	**Album**	**Song**
Andy Schmidt	Disillusion	Back to Times of Splendor	And The Mirror Cracked Fall; Alone I Stand In Fires; Back To Times Of Splendor; A Day By The Lake; The Sleep Of Restless Hours;
		Gloria	The Black Sea; Dread It; Avalanche; Gloria; The Hole We Are In; Save The Past; Too Many Broken Cease; Fires; Untiefen;
		The Liberation	Wintertide; The Great Unknown; A Shimmer in the Darkest Sea; The Liberation; Time to Let Go; The Mountain; Between;
		Ayam	Am Abgrund; Tormento; Driftwood; Abide the Storm; Longhope; Nine Days; From the Embers; The Brook;
Alexander Otto	Words of Farewell	Immersion	Project: Daybreak; Ever After; End Of Transmission; On Second Thought; The Great Escape; Urban Panorama; Sorae; Vagrant Story; Sundown Serenade;
		The Black Wild Yonder	Continuum Shift; Telltale Notion; In Kingdoms Of Rain; Beauty In Passing; The Outer Rim; Temporary Loss Of Reason; Antibiosis; Luminary Ghost; Riven; Overture;
		A Quiet World	My Share Of Loneliness; Gaia Demise; Gallows Frame; Limit Cycle; Zero Temperance; Momentary Life; Oversoul; The Farthest Reach; This Shadow My Likeness;
		Inner Universe	Chronotopos; Whispering Deeps; Offworld; Alter Memory;

		Inner Universe II	The Midnight Star; Born of Sleep; The Long Goodbye; Forgotten Hope;
Morean	Hannes Grossmann	Apophenia	The War on Intelligence; They; The Flying Pizza Conundrum
	Alkaloid	The Malkuth Grimoire	Carbon Phrases; From A Hadron Machinist; Cthulhu; Alter Magnitudes; Orgonism; Dyson Sphere I. Mining The Oort Cloud; Dyson Sphere II. Assembly; Dyson Sphere III. Kardashev II.1 – The God Oven; Dyson Sphere IV. Sol Omega; The Malkuth Grimoire; Funeral For A Continent;
		Liquid Anatomy	Kernel Panic; Azagthoth; Liquid Anatomy; Interstellar Boredom; Chaos Theory And Practice; Rise Of The Cephalopods;
		Numen	Qliphosis; The Cambrian Explosion; Clusterfuck; Shades of Shub-Niggurath; A Fool's Desire; The Fungi from Yuggoth; Numen (Dyson VII); Recursion (Dyson VIII); The Folding (Dyson IX); Alpha Aur;
	Dark Fortress	Eidolon	The Silver Gate; Cohorror; Baphomet; The Unflesh; Analepsy; Edge Of Night; No Longer Human; Catacrusis; Antiversum;
		Ylem	Ylem; Osiris; Silence; Evenfall; Redivider; Satan Bled; Hirudineans; Nemesis; The Valley; Wraith;
		Venereal Dawn	Venereal Dawn; Lloigor; Betrayal And Vengeance; Chrysalis; I Am The Jigsaw Of A Mad God; The Deep; Odem; Luciform; On Fever's Wings;
		Specters from the Old World	Coalescence; The Spider in the Web; Spectres from the Old World; Pali Aike; Pazuzu; Isa; Pulling at Threads; In Deepest Time; Swan Song;
Chris Birx	Motorejesus	Deathrider	Legion of Rock; Destroyer; 10 Feet Under; Ground; Deathrider; Distortion Sleep; The Howling; The Undertaken; Hellmachine; Invisible Man; Black Fuel Domination; Death Hammer Overload; The Evil;
		Wheels of Purgatory	Motor Discipline; Fist Of The Dragon; King Of The Dead End Road; Fuel The Warmachine; Hammer Of The Lord; West Of Hell; Wheels Of Purgatory; The Church (Of Booze And Kerosene); The Shadowman; Fire 99; Electric Rise;
		Dirty Pounding Gasoline	Powertool; Nitro; Return Of The Demons; Supersonic; Dirty Pounding Gasoline; The Black Days; The Seven; A New War Burning; Motorjesus; Unspoken;
		Electric Revelation	Trouble In Motor City; The Run; Speed Of The Beast; Back In The Action Car; Rust;

			100.000 Volt Survivor; Electric Revelation; Midnight Rider; The Warning; Resurrection Man; Dead Army; The Right Hand Of The Devil;
		Hellbreaker	Drive Through Fire; Battlezone; Hellbreaker; Beyond the Grave; Dead Rising; Car Wars; Firebreather; Lawgiver; Black Hole Overload; Back to the Bullet;
Jennifer Haben	Beyond the Black	Songs of Love and Death	In the Shadows; Songs of Love and Death; Unbroken; When Angels Fall; Pearl in a World of Dirt; Hallelujah; Running to the Edge; Numb; Drowning in Darkness; Afraid of the Dark; Fall into the Flames;
		Lost in Forever	Lost in Forever; Beautiful Lies; Written in Blood; Against the World; Beyond the Mirror; Halo of the Dark; Dies Irae; Forget My Name; Burning in Flames; Nevermore; Shine and Shade; Heaven in Hell; Love's a Burden; Night Will Fade; The Other Side; Our Little Time; Rage Before the Storm;
		Heart of the Hurricane	Hysteria; Heart of the Hurricane; Through the Mirror; Million Lightyears; Song for the Godless; Escape from the Earth; Beneath a Blackened Sky; Fairytale of Doom; My God is Dead; Dear Death; Scream for Me; Freedom; Breeze; Echo from the Past; Parade; The Wound So Deep; Spiderweb of Eyes; We Will Find a Way; Still Breathing;
		Horizons	Horizons; Misery; Wounded Heart; Some Kind of Monster; Human; Golden Pariahs; Marching On; You're Not Alone; Out of the Ashes; Paralyzed; Coming Home; I Won't Surrender; Welcome to My Wasteland;
		Beyond The Black	Is There Anybody Out There?; Reincarnation; Free Me; Winter Is Coming; Into The Light; Wide Awake; Dancing In The Dark; Raise Your Head; Not In Our Name; I Remember Dying;
Tamara Amedov	Visionatica	Force of Luna	Swamp of the World; Lilith; She Wolf; Imprinting Lies; Certainty of Benevolence; The Thorns; Totem; Never Will Die;
		Enigma Fire	The Pharaoh; Fear; Roxana, the Great; Dance of Fire; To the Fallen Roma; Incomplete; Secrets of the Ancestors; Rise from the Ashes;
Angela Gossow	Arch Enemy	Wages of Sin	Enemy Within; Ravenous; The First Deadly Sin;
		Anthem of Rebellion	Silent Wars; Dead Eyes See No Future; Leader of the Rats; Exist to Exit;

			Despicable Heroes; Dehumanization; Saints and Sinners;
		Doomsday Machine	Taking Back My Soul; Nemesis; My Apocalypse; Carry the Cross; I Am Legend / Out for Blood; Skeleton Dance; Mechanic God Creation; Slaves of Yesterday;
		Rise of the Tyrant	Blood on Your Hands; The Last Enemy; I Will Live Again; The Day You Died; Night Falls Fast; The Great Darkness; Vultures;
		Khaos Legions	Yesterday is Dead and Gone; Bloodstained Cross; Under Black Flags We March; No Gods, No Masters; City of the Dead; Through the Eyes of a Raven; Cruelty Without Beauty; Cult of Chaos; Thorns in My Flesh; Vengeance is Mine; Secrets;
Sebastian Levermann	Orden Ogan	Vale	To New Shores of Sadness; Winds of Vale; Farewell; Reality Lost; This Is; Something Pretending; The Lords of the Flies; And if You Do it Right; What I'm Recalling; A Friend of Mine; The Candle of Light;
		Easton Hope	Nobody Leaves; Goodbye; Easton Hope; Welcome Liberty; All These Dark Years; Nothing Remains; Requiem; We are Pirates; The Black Heart; Of Downfall and Decline;
		To the End	To the End; The Things We Believe in; Land of the Dead; The Ice Kings; Till the Stars Cry Out; This World of Ice; Dying Paradise; Mystic Symphony; Angels War; Take This Light;
		Ravenhead	Ravanhead; F.E.V.E.R; The Lake; Evil Lies in Every Man; Here at the End of the World; A Reason to Give; Deaf Among the Blind; Sorrow is Your Tale; Too Soon;
		Gunmen	Gunmen; Fields of Sorrow; Forlorn and Forsaken; Vampire in Ghost Town; Come With Me to the Other Side; The Face of Silence; Down Here; Ashen Rain; One Last Chance; Finis Coronat Opus;
		Final Days	Heart of the Android; In the Dawn of the AI Inferno; Let the Fire Rain; Interstellar; Alone in the Dark; Black Hole; Absolution for Our Final Days; Hollow; It is Over;
		The Order of Fear	Kings of the Underworld; The Order of Fear; Moon Fire; Conquest; Blind Man; Prince of Sorrow; Dread Lord; My Worst Enemy; Anthem to the Darkside; The Journey Thus Far; The Long Darkness;

English Speakers (US):

Singer	Band	Album	Song
Matt Heafy	Trivium	Ember to Inferno	Pillars Of Serpents; If I Could Collapse the Masses; Fugue (A Revelation); Requiem; Ember To Inferno; To Burn the Eye; Falling To Grey; My Hatred; When All Light Dies; Blinding Tears; Will Break The Skies; Demon;
		Ascendancy	Rain; Pull Harder on The Strings of Your Martyr; Drowned And Torn Asunder; Ascendancy; A Gunshot to The Head of Trepidation; Like Light to The Flies; Dying In Your Arms; The Deceived; Suffocating Sight; Departure;Declaration; Washing Away Me In The Tides;
		The Crusade	Ignition; Detonation; Entrance Of the Conflagration; Anthem (We Are the Fire); Unrepentant; And Sadness Will Sear; Becoming The Dragon; To The Rats; This World Can't Tear Us Apart; Tread The Floods; Contempt Breeds Contamination; The Rising;
		Shogun	Kirisute Gomen; Torn Between Scylla and Charybdis; Down From the Sky; Into The Mouth of Hell We March; Throes Of Perdition; Insurrection; The Calamity; He Who Spawned the Furies; Of Prometheus and The Crucifix; Like Callisto to A Star in Heaven; Shogun; Poison, The Knife or The Noose; Upon The Shores;
		In Waves	In Waves; Inception Of the End; Dusk Dismantled; Watch The World Burn Black; A Skyline's Severance; Built To Fall; Caustic Are the Ties That Bind; Forsake Not the Dream; Drowning In Slow Motion; A Grey So Dark; Chaos Reigns; Of All These Yesterdays; Leaving This World Behind; Shattering The Skies Above;
		Vengeance Falls	Brave This Storm; Vengeance Falls; Strife; No Way to Heal; To Believe; At The End of This War; Through Blood and Dirt and Bone; Villainy Thrives; Incineration: The Broken World; Wake (The End Is Nigh); No Hope For The Human Race; As I Am Exploding;
		Silence In the Snow	Silence In the Snow; Blind Leading the Blind; Dead And Gone; The Ghost That's Haunting You; Pull Me from The Void;

			Until The World Goes Cold; Rise Above the Tides; The Thing That's Killing Me; Beneath The Sun; Breathe In the Flames; Cease All Your Fire; The Darkness of My Mind;
		The Sin and The Sentence	The Sin and The Sentence; Beyond Oblivion; Other Worlds; The Heart from Your Hate; Betrayer; The Wretchedness Inside; Endless Night; Sever The Hand; Beauty In the Sorrow; The Revanchist; Thrown Into the Fire;
		What the Dead Men Say	What the Dead Men Say; Catastrophist; Amongst the Shadows and the Stones; Bleed into Me; The Defiant; Sickness Unto You; Scattering the Ashes; Bending the Arc to Fear; The Ones We Left Behind;
		In The Court of The Dragon	In The Court of The Dragon; Like A Sword Over Damocles; Feast Of Fire; A Crisis of Revelation; The Shadow of The Abattoir; No Way Back Just Through; Fall Into Your Hands; From Dawn to Decadence; The Phalanx;
Chuck Schuldiner	Death	Scream Bloody Gore	Infernal Death; Zombie Ritual; Denial Of Life; Sacrificial; Mutilation; Regurgitated Guts; Baptized In Blood; Torn To Pieces; Evil Dead; Scream Bloody Gore; Beyond The Unholy Grave; Land Of No Return;
		Leprosy	Leprosy; Born Dead; Forgotten Past; Left To Die; Pull The Plug; Open Casket; Primitive Ways; Choke On It;
		Spiritual Healing	Living Monstrosity; Altering The Future; Defensive Personalities; Within The Mind; Spiritual Healing; Low Life; Genetic Reconstruction; Killing Spree;
		Human	Flattening Of Emotions; Suicide Machine; Together As One; Secret Face; Lack Of Comprehension; See Through Dreams;
		Individual Thought Patterns	Vacant Planets; Overactive Imagination; In Human Form; Jealousy; Trapped In a Corner; Nothing Is Everything; Mentally Blind; Individual Thought Patterns; Destiny; Out Of Touch; The Philosopher;
		Symbolic	Symbolic; Zero Tolerance; Empty Words; Sacred Serenity; 1,000 Eyes; Without Judgement; Crystal Mountain; Misanthrope; Perennial Quest;
		The Sound of Perseverance	Scavenger Of Human Sorrow; Bite The Pain; Spirit Crusher; Story To Tell; The

			Flesh and The Power It Holds; To Forgive Is to Suffer; A Moment of Clarity;
Jon Oliva	Jon Oliva's Pain	Tage Mahal	The Dark; People Say - Gimme Some Hell; Guardian Of Forever; Slipping Away; Walk Alone; The Non Sensible Ravings Of The Lunatic Mind; No Escape; Father, Son, Holy Ghost; All The Time; Nowhere To Run; Pain; Outside The Door; Fly Away;
		Maniacal Renderings	Through The Eyes of The King; Maniacal Renderings; The Evil Beside You; Time to Die; The Answer; Push It to the Limit; Who's Playing God; Timeless Flight; Holes; End Times; Still I Pray for You Now; Reality's Fool; Only You;
		Global Warning	Global Warning; Look At the World; Adding The Cost; Firefly; Before I Hang; Master; The Ride; O to G; Walk Upon the Water; Stories; Open Up Your Eyes; You Never Know; Someone / Souls;
		Festival	Lies; Death Rides a Black Horse; Festival; Afterglow; Living On the Edge; Looking For Nothing; The Evil Within; Winter Haven; I Fear You; Now

<u>English Speakers (UK):</u>

Singer	**Band**	**Album**	**Song**
Bruce Dickenson	Iron Maiden	Piece Of Mind	Revelations; Flight Of Icarus; Die With Your Boots On; Sun And Steel;
		Powerslave	2 Minutes To Midnight; Flash Of the Blade; Back In the Village; Powerslave;
		Seventh Son of a Seventh Son	Moonchild; Can I Play with Madness?; The Evil That Men Do; Only The Good Die Young;
		No Prayer for The Dying	Tailgunner; Holy Smoke; Public Enema Number One; Run Silent Run Deep; Hooks In You; Bring Your Daughter... To The Slaughter;
		Fear Of the Dark	Be Quick Or Be Dead; Fear Is The Key; Wasting Love; Chains Of Misery; Judas Be My Guide;
		Brave New World	The Wicker Man; Ghost Of The Navigator; Brave New World; Out Of The Silent Planet;
		Dance Of Death	Rainmaker; Montségur; Gates Of Tomorrow; New Frontier; Face In The Sand; Journeyman;
		A Matter Of Life And Death	These Colours Don't Run; Brighter Than A Thousand Suns; The Longest Day; Out Of The Shadows; Lord Of Light;

		The Final Frontier	El Dorado; Coming Home; The Alchemist; Starblind;
		The Book Of Souls	If Eternity Should Fail; Speed Of Light; Death Or Glory; Empire Of The Clouds;
		Senjutsu	The Writing on the Wall; Days of Future Past; Darkest Hour;
	Bruce Dickinson	Tattooed Millionaire	Son Of a Gun; Tattooed Millionaire; Born In '58; Hell On Wheels; Gypsy Road; Dive! Dive! Dive!; All The Young Dudes; Lickin' The Gun; Zulu Lulu; No Lies;
		Balls To Picasso	Cyclops; Hell No; Gods Of War; 1000 Points Of Light; Laughing In The Hiding Bush; Change Of Heart; Shoot All The Clowns; Fire; Sacred Cowboys; Tears Of The Dragon;
		Skunkworks	Space Race; Back From The Edge; Inertia; Faith; Solar Confinement; Dreamstate; I Will Not Accept The Truth; Inside The Machine; Headswitch; Meltdown; Octavia; Innerspace; Strange Death In Paradise;
		Accident Of Birth	The Freak; Toltec 7 Arrival; Star Children; Taking The Queen; Darkside Of Aquarius; Road To Hell; Man Of Sorrows; Accident Of Birth; Magician; Welcome To The Pit; Omega; Arc Of Space;
		Chemical Wedding	King In Crimson; Chemical Wedding; The Tower; Killing Floor; Book Of Thel; Gates Of Urizen; Jerusalem; Trumpets Of Jericho; Machine Men; The Alchemist; Return Of The King;
		Tyranny Of Souls	Mars Within; Abduction; Soul Intruders; Kill Devil Hill; Navigate The Seas Of The Sun; River Of No Return; Power Of The Sun; Devil On A Hog; Believil; A Tyranny Of Souls;
		The Mandrake Project	Afterglow of Ragnarok; Many Doors to Hell; Rain on the Graves; Resurrection Men; Fingers in the Wounds; Mistress of Mercy; Face in the Mirror; Shadow of the Gods; Sonata (Immortal Beloved);
Ross Jennings	Haken	Aquarius	The Point Of No Return; Streams; Aquarium; Eternal Rain; Drowning In The Flood; Sun; Celestial Elixir;
		Visions	Nocturnal Conspiracy; Insomnia; The Mind's Eye; Shapeshifter; Deathless; Visions;

		The Mountain	Atlas Stone; In Memoriam; Falling Back; To Earth; Nobody;
		Affinity	Initiate; 1985; Lapse; The Architect; Earthrise; Red Giant; The Endless Knot; Bound By Gravity;
		Vector	The Good Doctor; Puzzle Box; Veil; Host; A Cell Divides;
		Virus	Prosthetic; Invasion; Carousel; The Strain; Canary Yellow; Messiah Complex I: Ivory Tower; Messiah Complex II: A Glutton for Punishment; Messiah Complex III: Marigold; Messiah Complex IV: The Sect; Messiah Complex V: Ectobius Rex; Only Stars;
		Fauna	Taurus; Nightingale; The Alphabet Of Me; Sempiternal Beings; Beneath The White Rainbow; Island In The Clouds; Lovebite; Elephants Never Forget; Eyes Of Ebony;
Nathanael Underwood	Damim	Purity (The Darwinian Paradox)	Spiritual Void; City Of Envy; No God With Me; Body Temples Of Sorrow; Fury; Fortunes Of Need; Frightening And Obscene;
		The Difference Engine	The Difference Engine; Eyeballing; Outside; Mirror-Image Ritual; Made Of Beasts; Gangrene. Purulence. Impact; A Wound That Never Heals; This Has Nothing To Do With Apathy;

Appendix B1 – Alternation and expected rates in Hebrew vowels

Vowel 1	Vowel 2	Obser.	Expe.	O/E
e	ɑ	0	0.04	0.00
ə	ɑ	1	1.91	0.52
ɛ	ɑ	3	3.51	0.85
i	ɑ	0	4.19	0.00
ɪ	ɑ	2	4.09	0.49
ɔ	ɑ	7	1.90	3.69
u	ɑ	0	1.18	0.00
ʊ	ɑ	0	0.13	0.00
ʌ	ɑ	14	1.51	9.29
æ	ɑ	5	2.13	2.35
aɪ	ɑ	1	6.09	0.16
aʊ	ɑ	3	0.99	3.05
eɪ	ɑ	0	5.39	0.00
əʊ	ɑ	0	0.01	0.00
oʊ	ɑ	6	2.71	2.22
ɑɪ	ɑ	2	0.61	3.28
eɪ	ɑ	0	0.01	0.00
ɜɪ	ɑ	2	0.81	2.47
ɔɪ	ɑ	6	1.18	5.07
əɪ	ɑ	0	2.35	0.00
ɔɪ	ɑ	0	0.15	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ə	e	0	0.14	0.00
ɛ	e	1	0.25	3.94
i	e	0	0.30	0.00
ɪ	e	3	0.30	10.13
ɔ	e	0	0.14	0.00
u	e	0	0.09	0.00
ʊ	e	0	0.01	0.00
ʌ	e	0	0.11	0.00
æ	e	2	0.15	12.98
aɪ	e	0	0.44	0.00
aʊ	e	0	0.07	0.00
eɪ	e	1	0.39	2.57
əʊ	e	0	0.00	0.00
oʊ	e	0	0.20	0.00
ɑɪ	e	0	0.04	0.00
eɪ	e	0	0.00	0.00
ɜɪ	e	0	0.06	0.00
ɔɪ	e	0	0.09	0.00
əɪ	e	0	0.17	0.00
ɔɪ	e	0	0.01	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɛ	ə	4	11.01	0.36
i	ə	0	13.13	0.00
ɪ	ə	9	12.83	0.70
ɔ	ə	4	5.94	0.67
u	ə	0	3.68	0.00
ʊ	ə	0	0.41	0.00
ʌ	ə	0	4.72	0.00
æ	ə	0	6.68	0.00
aɪ	ə	0	19.07	0.00
aʊ	ə	0	3.09	0.00
eɪ	ə	3	16.88	0.18
əʊ	ə	0	0.05	0.00
oʊ	ə	2	8.47	0.24
ɑɪ	ə	0	1.91	0.00
eɪ	ə	0	0.05	0.00
ɜɪ	ə	0	2.53	0.00
ɔɪ	ə	1	3.71	0.27
əɪ	ə	4	7.37	0.54
ɔɪ	ə	0	0.46	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
i	ɛ	3	24.13	0.12
ɪ	ɛ	14	23.58	0.59
ɔ	ɛ	4	10.92	0.37
u	ɛ	0	6.77	0.00

ʊ	ɛ	0	0.76	0.00
ʌ	ɛ	1	8.68	0.12
æ	ɛ	56	12.28	4.56
aɪ	ɛ	2	35.06	0.06
aʊ	ɛ	0	5.67	0.00
eɪ	ɛ	52	31.03	1.68
əʊ	ɛ	0	0.08	0.00
oʊ	ɛ	1	15.58	0.06
ɑɪ	ɛ	2	3.51	0.57
eɹ	ɛ	0	0.08	0.00
ɜɪ	ɛ	10	4.66	2.15
ɔɪ	ɛ	0	6.82	0.00
əɪ	ɛ	0	13.55	0.00
ɔɪ	ɛ	0	0.85	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɪ	i	78	28.12	2.77
ɔ	i	0	13.03	0.00
u	i	1	8.08	0.12
ʊ	i	0	0.91	0.00
ʌ	i	1	10.35	0.10
æ	i	3	14.64	0.20
aɪ	i	2	41.80	0.05
aʊ	i	0	6.77	0.00
eɪ	i	9	37.01	0.24
əʊ	i	0	0.10	0.00
oʊ	i	1	18.58	0.05
ɑɪ	i	0	4.19	0.00
eɹ	i	0	0.10	0.00
ɜɪ	i	1	5.55	0.18
ɔɪ	i	0	8.13	0.00
əɪ	i	0	16.16	0.00
ɔɪ	i	0	1.01	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɔ	ɪ	3	12.73	0.24
u	ɪ	0	7.89	0.00
ʊ	ɪ	0	0.89	0.00
ʌ	ɪ	2	10.11	0.20
æ	ɪ	3	14.31	0.21
aɪ	ɪ	4	40.85	0.10
aʊ	ɪ	0	6.61	0.00
eɪ	ɪ	11	36.16	0.30
əʊ	ɪ	0	0.10	0.00
oʊ	ɪ	0	18.16	0.00
ɑɪ	ɪ	0	4.09	0.00
eɹ	ɪ	0	0.10	0.00
ɜɪ	ɪ	0	5.43	0.00
ɔɪ	ɪ	0	7.94	0.00
əɪ	ɪ	1	15.79	0.06
ɔɪ	ɪ	0	0.99	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
u	ɔ	0	3.66	0.00
ʊ	ɔ	0	0.41	0.00
ʌ	ɔ	16	4.68	3.42
æ	ɔ	2	6.63	0.30
aɪ	ɔ	0	18.92	0.00
aʊ	ɔ	4	3.06	1.31
eɪ	ɔ	2	16.75	0.12
əʊ	ɔ	0	0.05	0.00
oʊ	ɔ	54	8.41	6.42
ɑɪ	ɔ	3	1.90	1.58
eɹ	ɔ	0	0.05	0.00
ɜɪ	ɔ	4	2.51	1.59
ɔɪ	ɔ	9	3.68	2.45
əɪ	ɔ	0	7.31	0.00
ɔɪ	ɔ	1	0.46	2.19
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ʊ	u	7	0.26	27.44
ʌ	u	1	2.91	0.34
æ	u	0	4.11	0.00
aɪ	u	0	11.73	0.00

aʊ	u	1	1.90	0.53
eɪ	u	1	10.39	0.10
əʊ	u	0	0.03	0.00
oʊ	u	3	5.22	0.58
ɑɪ	u	0	1.18	0.00
eɹ	u	0	0.03	0.00
ɜɹ	u	1	1.56	0.64
ɔɹ	u	0	2.28	0.00
əɹ	u	0	4.53	0.00
ɔɪ	u	0	0.28	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ʌ	ʊ	0	0.33	0.00
æ	ʊ	0	0.46	0.00
aɪ	ʊ	0	1.32	0.00
aʊ	ʊ	0	0.21	0.00
eɪ	ʊ	0	1.17	0.00
əʊ	ʊ	0	0.00	0.00
oʊ	ʊ	1	0.59	1.70
ɑɪ	ʊ	0	0.13	0.00
eɹ	ʊ	0	0.00	0.00
ɜɹ	ʊ	0	0.18	0.00
ɔɹ	ʊ	0	0.26	0.00
əɹ	ʊ	0	0.51	0.00
ɔɪ	ʊ	0	0.03	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
æ	ʌ	7	5.27	1.33
aɪ	ʌ	5	15.03	0.33
aʊ	ʌ	11	2.43	4.52
eɪ	ʌ	1	13.31	0.08
əʊ	ʌ	0	0.04	0.00
oʊ	ʌ	7	6.68	1.05
ɑɪ	ʌ	4	1.51	2.65
eɹ	ʌ	1	0.04	27.54
ɜɹ	ʌ	4	2.00	2.00
ɔɹ	ʌ	1	2.92	0.34

əɹ	ʌ	0	5.81	0.00
ɔɪ	ʌ	1	0.36	2.75
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
aɪ	æ	4	21.27	0.19
aʊ	æ	0	3.44	0.00
eɪ	æ	28	18.83	1.49
əʊ	æ	0	0.05	0.00
oʊ	æ	1	9.45	0.11
ɑɪ	æ	9	2.13	4.22
eɹ	æ	0	0.05	0.00
ɜɹ	æ	3	2.83	1.06
ɔɹ	æ	1	4.14	0.24
əɹ	æ	0	8.22	0.00
ɔɪ	æ	0	0.51	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
aʊ	aɪ	6	9.83	0.61
eɪ	aɪ	0	53.76	0.00
əʊ	aɪ	0	0.15	0.00
oʊ	aɪ	0	26.99	0.00
ɑɪ	aɪ	6	6.09	0.99
eɹ	aɪ	0	0.15	0.00
ɜɹ	aɪ	0	8.07	0.00
ɔɹ	aɪ	0	11.81	0.00
əɹ	aɪ	0	23.47	0.00
ɔɪ	aɪ	0	1.47	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
eɪ	aʊ	1	8.70	0.11
əʊ	aʊ	0	0.02	0.00
oʊ	aʊ	1	4.37	0.23
ɑɪ	aʊ	3	0.99	3.05
eɹ	aʊ	0	0.02	0.00
ɜɹ	aʊ	0	1.31	0.00
ɔɹ	aʊ	0	1.91	0.00
əɹ	aʊ	0	3.80	0.00
ɔɪ	aʊ	0	0.24	0.00

Vowel 1	Vowel 2	Obser.	Expe.	O/E
əʊ	eɪ	0	0.13	0.00
oʊ	eɪ	2	23.89	0.08
ɑɪ	eɪ	0	5.39	0.00
eɹ	eɪ	1	0.13	7.70
ɜɹ	eɪ	3	7.14	0.42
ɔɹ	eɪ	1	10.45	0.10
əɹ	eɪ	0	20.78	0.00
ɔɪ	eɪ	0	1.30	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
oʊ	əʊ	2	0.07	30.68
ɑɪ	əʊ	0	0.01	0.00
eɹ	əʊ	0	0.00	0.00
ɜɹ	əʊ	0	0.02	0.00
ɔɹ	əʊ	0	0.03	0.00
əɹ	əʊ	0	0.06	0.00
ɔɪ	əʊ	0	0.00	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɑɪ	oʊ	0	2.71	0.00
eɹ	oʊ	1	0.07	15.34
ɜɹ	oʊ	14	3.59	3.90
ɔɹ	oʊ	12	5.25	2.29
əɹ	oʊ	0	10.43	0.00
ɔɪ	oʊ	2	0.65	3.07
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
eɹ	ɑɪ	0	0.01	0.00
ɜɹ	ɑɪ	1	0.00	2,822.50
ɔɹ	ɑɪ	0	0.02	0.00
əɹ	ɑɪ	0	0.03	0.00
ɔɪ	ɑɪ	0	0.06	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɜɹ	eɹ	3	0.02	153.95
ɔɹ	eɹ	2	0.03	70.12
əɹ	eɹ	0	0.06	0.00
ɔɪ	eɹ	0	0.00	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɔɹ	ɜɹ	16	1.57	10.20
əɹ	ɜɹ	0	3.12	0.00
ɔɪ	ɜɹ	0	0.19	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
əɹ	ɔɹ	0	4.56	0.00
ɔɪ	ɔɹ	1	0.29	3.51
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɔɪ	əɹ	0	0.57	0.00

Appendix B2 – Alternation and expected rates in Hebrew consonants

Cons. 1	Cons.2	Obser.	Expe.	O/E
d	b	3	0.45	6.73
ð	b	0	0.01	0.00
d͡ʒ	b	1	0.02	56.47
f	b	0	0.04	0.00
g	b	0	0.01	0.00
j	b	0	0.00	0.00
k	b	0	0.11	0.00
l	b	0	0.28	0.00
m	b	0	0.17	0.00
n	b	0	0.68	0.00
ŋ	b	0	0.10	0.00
p	b	0	0.04	0.00
ɹ	b	0	0.00	0.00
s	b	0	0.27	0.00
ʃ	b	0	0.02	0.00
t	b	0	0.33	0.00
t͡ʃ	b	0	0.01	0.00
v	b	3	0.09	35.29
w	b	0	0.00	0.00
z	b	0	0.34	0.00
ʒ	b	0	0.00	0.00
θ	b	0	0.04	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ð	d	3	1.41	2.13
d͡ʒ	d	4	2.23	1.79
f	d	5	4.75	1.05
g	d	2	1.19	1.68
j	d	0	0.00	0.00
k	d	5	13.67	0.37
l	d	5	35.58	0.14
m	d	5	20.95	0.24
n	d	21	85.05	0.25
ŋ	d	3	11.96	0.25
p	d	3	4.98	0.60
ɹ	d	0	0.59	0.00
s	d	3	34.10	0.09
ʃ	d	0	2.75	0.00
t	d	34	41.97	0.81
t͡ʃ	d	0	1.49	0.00
v	d	12	10.70	1.12
w	d	0	0.00	0.00
z	d	22	42.49	0.52
ʒ	d	0	0.52	0.00
θ	d	4	4.61	0.87
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
d͡ʒ	ð	0	0.06	0.00
f	ð	0	0.12	0.00
g	ð	0	0.03	0.00
j	ð	0	0.00	0.00
k	ð	0	0.34	0.00
l	ð	0	0.90	0.00
m	ð	0	0.53	0.00
n	ð	1	2.14	0.47
ŋ	ð	0	0.30	0.00
p	ð	0	0.13	0.00
ɹ	ð	0	0.01	0.00
s	ð	0	0.86	0.00
ʃ	ð	0	0.07	0.00
t	ð	0	1.06	0.00
t͡ʃ	ð	0	0.04	0.00
v	ð	1	0.27	3.71
w	ð	0	0.00	0.00
z	ð	2	1.07	1.87
ʒ	ð	0	0.01	0.00
θ	ð	0	0.12	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
f	d͡ʒ	0	0.19	0.00

g	d͡ʒ	0	0.05	0.00
j	d͡ʒ	0	0.00	0.00
k	d͡ʒ	0	0.54	0.00
l	d͡ʒ	0	1.41	0.00
m	d͡ʒ	0	0.83	0.00
n	d͡ʒ	0	3.38	0.00
ŋ	d͡ʒ	0	0.48	0.00
p	d͡ʒ	0	0.20	0.00
ɹ	d͡ʒ	0	0.02	0.00
s	d͡ʒ	3	1.35	2.21
ʃ	d͡ʒ	0	0.11	0.00
t	d͡ʒ	0	1.67	0.00
t͡ʃ	d͡ʒ	1	0.06	16.94
v	d͡ʒ	1	0.43	2.35
w	d͡ʒ	0	0.00	0.00
z	d͡ʒ	1	1.69	0.59
ʒ	d͡ʒ	0	0.02	0.00
θ	d͡ʒ	0	0.18	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
g	f	0	0.10	0.00
j	f	0	0.00	0.00
k	f	0	1.16	0.00
l	f	1	3.02	0.33
m	f	1	1.78	0.56
n	f	4	7.21	0.55
ŋ	f	2	1.01	1.97
p	f	1	0.42	2.37
ɹ	f	0	0.05	0.00
s	f	1	2.89	0.35
ʃ	f	1	0.23	4.29
t	f	6	3.56	1.69
t͡ʃ	f	0	0.13	0.00
v	f	2	0.91	2.21
w	f	0	0.00	0.00
z	f	6	3.60	1.67

ʒ	f	0	0.04	0.00
θ	f	4	0.39	10.25
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
j	g	0	0.00	0.00
k	g	0	0.29	0.00
l	g	0	0.75	0.00
m	g	1	0.44	2.25
n	g	0	1.80	0.00
ŋ	g	0	0.25	0.00
p	g	0	0.11	0.00
ɹ	g	0	0.01	0.00
s	g	1	0.72	1.38
ʃ	g	0	0.06	0.00
t	g	0	0.89	0.00
t͡ʃ	g	0	0.03	0.00
v	g	1	0.23	4.41
w	g	0	0.00	0.00
z	g	0	0.90	0.00
ʒ	g	0	0.01	0.00
θ	g	0	0.10	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
k	j	0	0.00	0.00
l	j	0	0.00	0.00
m	j	0	0.00	0.00
n	j	0	0.00	0.00
ŋ	j	0	0.00	0.00
p	j	0	0.00	0.00
ɹ	j	0	0.00	0.00
s	j	0	0.00	0.00
ʃ	j	0	0.00	0.00
t	j	0	0.00	0.00
t͡ʃ	j	0	0.00	0.00
v	j	0	0.00	0.00
w	j	0	0.00	0.00
z	j	0	0.00	0.00

ʒ	j	0	0.00	0.00
θ	j	0	0.00	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
l	k	2	8.67	0.23
m	k	0	5.11	0.00
n	k	5	20.73	0.24
ŋ	k	0	2.91	0.00
p	k	0	1.21	0.00
ɹ	k	0	0.14	0.00
s	k	1	8.31	0.12
ʃ	k	1	0.67	1.49
t	k	15	10.23	1.47
tʃ	k	0	0.36	0.00
v	k	1	2.61	0.38
w	k	0	0.00	0.00
z	k	2	10.35	0.19
ʒ	k	0	0.13	0.00
θ	k	2	1.12	1.78
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
m	l	12	13.29	0.90
n	l	30	53.96	0.56
ŋ	l	6	7.59	0.79
p	l	0	3.16	0.00
ɹ	l	7	0.38	18.57
s	l	1	21.63	0.05
ʃ	l	0	1.74	0.00
t	l	5	26.63	0.19
tʃ	l	0	0.94	0.00
v	l	3	6.79	0.44
w	l	0	0.00	0.00
z	l	0	26.96	0.00
ʒ	l	0	0.33	0.00
θ	l	0	2.92	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
n	m	81	31.77	2.55
ŋ	m	4	4.47	0.90
p	m	4	1.86	2.15
ɹ	m	1	0.22	4.51
s	m	5	12.73	0.39
ʃ	m	1	1.03	0.97
t	m	4	15.68	0.26
tʃ	m	0	0.55	0.00
v	m	4	4.00	1.00
w	m	0	0.00	0.00
z	m	6	15.87	0.38
ʒ	m	0	0.19	0.00
θ	m	1	1.72	0.58
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ŋ	n	20	18.14	1.10
p	n	2	7.55	0.26
ɹ	n	0	0.90	0.00
s	n	4	51.71	0.08
ʃ	n	1	4.17	0.24
t	n	6	63.65	0.09
tʃ	n	0	2.25	0.00
v	n	6	16.22	0.37
w	n	0	0.00	0.00
z	n	10	64.44	0.16
ʒ	n	0	0.79	0.00
θ	n	0	6.98	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
p	ŋ	1	1.06	0.94
ɹ	ŋ	0	0.13	0.00
s	ŋ	2	7.27	0.28
ʃ	ŋ	0	0.59	0.00
t	ŋ	1	8.95	0.11
tʃ	ŋ	0	0.32	0.00
v	ŋ	1	2.28	0.44
w	ŋ	0	0.00	0.00
z	ŋ	0	9.06	0.00

ʒ	ŋ	0	0.11	0.00
θ	ŋ	0	0.98	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ɹ	p	0	0.05	0.00
s	p	0	3.03	0.00
ʃ	p	0	0.24	0.00
t	p	6	3.72	1.61
tʃ	p	0	0.13	0.00
v	p	3	0.95	3.16
w	p	0	0.00	0.00
z	p	0	3.77	0.00
ʒ	p	0	0.05	0.00
θ	p	1	0.41	2.45
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
s	ɹ	0	0.36	0.00
ʃ	ɹ	0	0.03	0.00
t	ɹ	0	0.44	0.00
tʃ	ɹ	0	0.02	0.00
v	ɹ	0	0.11	0.00
w	ɹ	0	0.00	0.00
z	ɹ	0	0.45	0.00
ʒ	ɹ	0	0.01	0.00
θ	ɹ	0	0.05	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ʃ	s	3	1.67	1.80
t	s	5	25.52	0.20
tʃ	s	1	0.90	1.11
v	s	1	6.50	0.15
w	s	0	0.00	0.00
z	s	34	25.83	1.32
ʒ	s	0	0.32	0.00
θ	s	6	2.80	2.14
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
t	ʃ	0	2.06	0.00
tʃ	ʃ	1	0.07	13.74
v	ʃ	0	0.52	0.00
w	ʃ	0	0.00	0.00
z	ʃ	0	2.08	0.00
ʒ	ʃ	4	0.03	156.97
θ	ʃ	0	0.23	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
tʃ	t	0	1.11	0.00
v	t	7	8.00	0.87
w	t	0	0.00	0.00
z	t	5	31.80	0.16
ʒ	t	1	0.39	2.57
θ	t	9	3.45	2.61
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
v	tʃ	0	0.28	0.00
w	tʃ	0	0.00	0.00
z	tʃ	0	1.13	0.00
ʒ	tʃ	0	0.01	0.00
θ	tʃ	1	0.12	8.20
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
w	v	0	0.00	0.00
z	v	7	8.10	0.86
ʒ	v	0	0.10	0.00
θ	v	1	0.88	1.14
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
z	w	0	0.00	0.00
ʒ	w	0	0.00	0.00
θ	w	0	0.00	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ʒ	z	0	0.39	0.00
θ	z	4	3.49	1.15
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
θ	ʒ	0	0.04	0.00

Appendix C1 – Alternation and expected rates in German vowels

Vowel 1	Vowel 2	Obser.	Expe.	O/E
ə	ɑ	6	3.37	1.78
ɛ	ɑ	2	4.49	0.45
i	ɑ	0	7.31	0.00
ɪ	ɑ	1	6.29	0.16
ɔ	ɑ	3	2.41	1.24
u	ɑ	0	1.45	0.00
ʊ	ɑ	0	0.16	0.00
ʌ	ɑ	24	2.57	9.35
æ	ɑ	5	2.22	2.25
aɪ	ɑ	2	9.14	0.22
aʊ	ɑ	2	1.44	1.39
eɪ	ɑ	1	6.70	0.15
oʊ	ɑ	7	3.44	2.04
ɑɪ	ɑ	2	1.28	1.57
ɜɪ	ɑ	1	1.33	0.75
ɔɪ	ɑ	4	1.75	2.29
əɪ	ɑ	0	3.36	0.00
ɔɪ	ɑ	0	0.38	0.00
ə	ɑ	6	3.37	1.78
ɛ	ɑ	2	4.49	0.45
i	ɑ	0	7.31	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɛ	ə	10	16.07	0.62
i	ə	0	26.20	0.00
ɪ	ə	17	22.55	0.75
ɔ	ə	2	8.64	0.23
u	ə	0	5.19	0.00
ʊ	ə	0	0.56	0.00
ʌ	ə	1	9.20	0.11
æ	ə	7	7.97	0.88
aɪ	ə	0	32.73	0.00
aʊ	ə	1	5.16	0.19
eɪ	ə	4	24.01	0.17
oʊ	ə	4	12.31	0.32
ɑɪ	ə	1	4.57	0.22
ɜɪ	ə	1	4.77	0.21
ɔɪ	ə	1	6.26	0.16
əɪ	ə	6	12.03	0.50
ɔɪ	ə	1	1.35	0.74
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
i	ɛ	2	34.91	0.06
ɪ	ɛ	19	30.05	0.63
ɔ	ɛ	1	11.51	0.09
u	ɛ	1	6.91	0.14
ʊ	ɛ	0	0.75	0.00
ʌ	ɛ	1	12.26	0.08
æ	ɛ	59	10.62	5.56
aɪ	ɛ	2	43.62	0.05
aʊ	ɛ	0	6.88	0.00
eɪ	ɛ	45	32.00	1.41
oʊ	ɛ	4	16.41	0.24
ɑɪ	ɛ	0	6.09	0.00
ɜɪ	ɛ	9	6.35	1.42
ɔɪ	ɛ	0	8.34	0.00
əɪ	ɛ	0	16.04	0.00
ɔɪ	ɛ	0	1.79	0.00
i	ɛ	2	34.91	0.06
ɪ	ɛ	19	30.05	0.63
ɔ	ɛ	1	11.51	0.09
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɪ	i	48	48.98	0.98
ɔ	i	0	18.77	0.00
u	i	2	11.27	0.18
ʊ	i	0	1.22	0.00
ʌ	i	0	19.98	0.00
æ	i	0	17.30	0.00
aɪ	i	4	71.10	0.06
aʊ	i	0	11.21	0.00
eɪ	i	10	52.15	0.19

oʊ	i	1	26.75	0.04
ɑɪ	i	0	9.93	0.00
ɜɪ	i	1	10.36	0.10
ɔɪ	i	0	13.59	0.00
əɪ	i	0	26.14	0.00
ɔɪ	i	0	2.92	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɔ	ɪ	0	16.15	0.00
u	ɪ	2	9.70	0.21
ʊ	ɪ	0	1.05	0.00
ʌ	ɪ	1	17.20	0.06
æ	ɪ	4	14.89	0.27
aɪ	ɪ	3	61.20	0.05
aʊ	ɪ	0	9.65	0.00
eɪ	ɪ	12	44.89	0.27
oʊ	ɪ	0	23.02	0.00
ɑɪ	ɪ	0	8.55	0.00
ɜɪ	ɪ	3	8.92	0.34
ɔɪ	ɪ	0	11.70	0.00
əɪ	ɪ	5	22.50	0.22
ɔɪ	ɪ	0	2.52	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
u	ɔ	1	3.72	0.27
ʊ	ɔ	1	0.40	2.49
ʌ	ɔ	36	6.59	5.46
æ	ɔ	2	5.71	0.35
aɪ	ɔ	0	23.45	0.00
aʊ	ɔ	0	3.70	0.00
eɪ	ɔ	0	17.20	0.00
oʊ	ɔ	27	8.82	3.06
ɑɪ	ɔ	2	3.27	0.61
ɜɪ	ɔ	6	3.42	1.76
ɔɪ	ɔ	21	4.48	4.69
əɪ	ɔ	0	8.62	0.00
ɔɪ	ɔ	3	0.96	3.11
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**

ʊ	u	1	0.24	4.14
ʌ	u	0	3.96	0.00
æ	u	0	3.43	0.00
aɪ	u	1	14.08	0.07
aʊ	u	0	2.22	0.00
eɪ	u	0	10.33	0.00
oʊ	u	2	5.30	0.38
ɑɪ	u	0	1.97	0.00
ɜɪ	u	0	2.05	0.00
ɔɪ	u	0	2.69	0.00
əɪ	u	1	5.18	0.19
ɔɪ	u	0	0.58	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ʌ	ʊ	1	0.43	2.34
æ	ʊ	0	0.37	0.00
aɪ	ʊ	0	1.52	0.00
aʊ	ʊ	0	0.24	0.00
eɪ	ʊ	0	1.12	0.00
oʊ	ʊ	0	0.57	0.00
ɑɪ	ʊ	0	0.21	0.00
ɜɪ	ʊ	0	0.22	0.00
ɔɪ	ʊ	0	0.29	0.00
əɪ	ʊ	0	0.56	0.00
ɔɪ	ʊ	0	0.06	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
æ	ʌ	7	6.08	1.15
aɪ	ʌ	4	24.97	0.16
aʊ	ʌ	7	3.94	1.78
eɪ	ʌ	1	18.31	0.05
oʊ	ʌ	7	9.39	0.75
ɑɪ	ʌ	10	3.49	2.87
ɜɪ	ʌ	4	3.64	1.10
ɔɪ	ʌ	4	4.77	0.84
əɪ	ʌ	0	9.18	0.00
ɔɪ	ʌ	0	1.03	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**

aɪ	æ	2	21.62	0.09
aʊ	æ	0	3.41	0.00
eɪ	æ	12	15.86	0.76
oʊ	æ	2	8.13	0.25
ɑɪ	æ	2	3.02	0.66
ɜɪ	æ	1	3.15	0.32
ɔɪ	æ	0	4.13	0.00
əɪ	æ	0	7.95	0.00
ɔɪ	æ	0	0.89	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
aʊ	aɪ	4	14.01	0.29
eɪ	aɪ	4	65.16	0.06
oʊ	aɪ	0	33.42	0.00
ɑɪ	aɪ	5	12.41	0.40
ɜɪ	aɪ	0	12.94	0.00
ɔɪ	aɪ	0	16.98	0.00
əɪ	aɪ	0	32.66	0.00
ɔɪ	aɪ	2	3.65	0.55
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
eɪ	aʊ	1	10.27	0.10
oʊ	aʊ	3	5.27	0.57
ɑɪ	aʊ	2	1.96	1.02
ɜɪ	aʊ	0	2.04	0.00
ɔɪ	aʊ	0	2.68	0.00
əɪ	aʊ	0	5.15	0.00
ɔɪ	aʊ	0	0.58	0.00
eɪ	aʊ	1	10.27	0.10
oʊ	aʊ	3	5.27	0.57
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
oʊ	eɪ	2	24.51	0.08
ɑɪ	eɪ	1	9.10	0.11
ɜɪ	eɪ	7	9.49	0.74
ɔɪ	eɪ	1	12.45	0.08
əɪ	eɪ	0	23.95	0.00
ɔɪ	eɪ	0	2.68	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɑɪ	oʊ	2	4.67	0.43
ɜɪ	oʊ	8	4.87	1.64
ɔɪ	oʊ	11	6.39	1.72
əɪ	oʊ	0	12.29	0.00
ɔɪ	oʊ	3	1.37	2.18
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɔɪ	ɜɪ	5	2.47	2.02
əɪ	ɜɪ	0	4.76	0.00
ɔɪ	ɜɪ	1	0.53	1.88
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
əɪ	ɔɪ	2	6.24	0.32
ɔɪ	ɔɪ	1	0.70	1.43
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɔɪ	əɪ	0	1.34	0.00

Appendix C2 – Alternation and expected rates in German consonants

Cons. 1	Cons.2	Obser.	Expe.	O/E
d	b	0.00	0.40	0.00
ð	b	0.00	0.01	0.00
d͡ʒ	b	0.00	0.02	0.00
f	b	0.00	0.04	0.00
g	b	0.00	0.01	0.00
k	b	0.00	0.09	0.00
l	b	1.00	0.28	3.57
m	b	0.00	0.17	0.00
n	b	0.00	0.66	0.00
ŋ	b	0.00	0.14	0.00
p	b	1.00	0.05	19.57
ɹ	b	0.00	0.00	0.00
s	b	0.00	0.26	0.00
ʃ	b	0.00	0.02	0.00
t	b	0.00	0.34	0.00
t͡ʃ	b	0.00	0.00	0.00
v	b	0.00	0.10	0.00
z	b	1.00	0.36	2.77

ʒ	b	0.00	0.00	0.00
θ	b	0.00	0.03	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ð	d	2.00	2.14	0.93
d͡ʒ	d	2.00	3.48	0.58
f	d	9.00	5.55	1.62
g	d	0.00	0.94	0.00
k	d	9.00	13.57	0.66
l	d	8.00	41.45	0.19
m	d	2.00	24.74	0.08
n	d	5.00	98.27	0.05
ŋ	d	4.00	20.19	0.20
p	d	6.00	7.55	0.79
ɹ	d	1.00	0.53	1.87
s	d	6.00	38.44	0.16
ʃ	d	0.00	2.54	0.00
t	d	115.00	50.74	2.27
t͡ʃ	d	2.00	0.60	3.32
v	d	11.00	14.91	0.74
z	d	25.00	53.28	0.47
ʒ	d	0.00	0.60	0.00
θ	d	1.00	4.28	0.23
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
d͡ʒ	ð	0.00	0.13	0.00
f	ð	1.00	0.20	5.00
g	ð	0.00	0.03	0.00
k	ð	0.00	0.49	0.00
l	ð	0.00	1.50	0.00
m	ð	0.00	0.89	0.00
n	ð	0.00	3.55	0.00
ŋ	ð	0.00	0.73	0.00
p	ð	0.00	0.27	0.00
ɹ	ð	1.00	0.02	51.83
s	ð	2.00	1.39	1.44
ʃ	ð	0.00	0.09	0.00
t	ð	4.00	1.83	2.19

t͡ʃ	ð	0.00	0.02	0.00
v	ð	10.00	0.54	18.59
z	ð	2.00	1.92	1.04
ʒ	ð	1.00	0.02	46.07
θ	ð	0.00	0.15	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
f	d͡ʒ	0.00	0.33	0.00
g	d͡ʒ	0.00	0.05	0.00
k	d͡ʒ	0.00	0.80	0.00
l	d͡ʒ	1.00	2.43	0.41
m	d͡ʒ	1.00	1.45	0.69
n	d͡ʒ	3.00	5.76	0.52
ŋ	d͡ʒ	0.00	1.18	0.00
p	d͡ʒ	1.00	0.44	2.26
ɹ	d͡ʒ	0.00	0.03	0.00
s	d͡ʒ	1.00	2.25	0.44
ʃ	d͡ʒ	1.00	0.15	6.71
t	d͡ʒ	0.00	2.97	0.00
t͡ʃ	d͡ʒ	3.00	0.04	85.05
v	d͡ʒ	0.00	0.87	0.00
z	d͡ʒ	1.00	3.12	0.32
ʒ	d͡ʒ	0.00	0.04	0.00
θ	d͡ʒ	0.00	0.25	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
g	f	1.00	0.09	11.42
k	f	2.00	1.27	1.57
l	f	1.00	3.88	0.26
m	f	2.00	2.31	0.86
n	f	1.00	9.20	0.11
ŋ	f	1.00	1.89	0.53
p	f	1.00	0.71	1.41
ɹ	f	0.00	0.05	0.00
s	f	4.00	3.60	1.11
ʃ	f	0.00	0.24	0.00
t	f	11.00	4.75	2.32
t͡ʃ	f	0.00	0.06	0.00

v	f	8.00	1.40	5.73
z	f	10.00	4.99	2.01
ʒ	f	0.00	0.06	0.00
θ	f	2.00	0.40	5.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
k	g	0.00	0.21	0.00
l	g	1.00	0.65	1.53
m	g	2.00	0.39	5.12
n	g	0.00	1.55	0.00
ŋ	g	0.00	0.32	0.00
p	g	0.00	0.12	0.00
ɹ	g	0.00	0.01	0.00
s	g	1.00	0.61	1.65
ʃ	g	0.00	0.04	0.00
t	g	2.00	0.80	2.50
t͡ʃ	g	0.00	0.01	0.00
v	g	0.00	0.24	0.00
z	g	0.00	0.84	0.00
ʒ	g	0.00	0.01	0.00
θ	g	0.00	0.07	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
l	k	3.00	9.49	0.32
m	k	2.00	5.66	0.35
n	k	6.00	22.49	0.27
ŋ	k	0.00	4.62	0.00
p	k	8.00	1.73	4.63
ɹ	k	0.00	0.12	0.00
s	k	2.00	8.80	0.23
ʃ	k	0.00	0.58	0.00
t	k	29.00	11.61	2.50
t͡ʃ	k	3.00	0.14	21.79
v	k	3.00	3.41	0.88
z	k	3.00	12.19	0.25
ʒ	k	0.00	0.14	0.00
θ	k	1.00	0.98	1.02
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**

m	l	12.00	17.29	0.69
n	l	43.00	68.69	0.63
ŋ	l	3.00	14.11	0.21
p	l	2.00	5.28	0.38
ɹ	l	1.00	0.37	2.68
s	l	4.00	26.87	0.15
ʃ	l	0.00	1.78	0.00
t	l	4.00	35.47	0.11
t͡ʃ	l	0.00	0.42	0.00
v	l	6.00	10.42	0.58
z	l	6.00	37.24	0.16
ʒ	l	0.00	0.42	0.00
θ	l	1.00	2.99	0.33
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
n	m	119.00	40.99	2.90
ŋ	m	7.00	8.42	0.83
p	m	2.00	3.15	0.63
ɹ	m	1.00	0.22	4.48
s	m	2.00	16.03	0.12
ʃ	m	0.00	1.06	0.00
t	m	15.00	21.17	0.71
t͡ʃ	m	0.00	0.25	0.00
v	m	5.00	6.22	0.80
z	m	3.00	22.23	0.13
ʒ	m	0.00	0.25	0.00
θ	m	3.00	1.78	1.68
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ŋ	n	44.00	33.46	1.32
p	n	4.00	12.52	0.32
ɹ	n	0.00	0.89	0.00
s	n	5.00	63.71	0.08
ʃ	n	1.00	4.21	0.24
t	n	13.00	84.09	0.15
t͡ʃ	n	0.00	1.00	0.00
v	n	7.00	24.71	0.28
z	n	9.00	88.30	0.10

ʒ	n	0.00	1.00	0.00
θ	n	1.00	7.09	0.14
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
p	ŋ	1.00	2.57	0.39
ɹ	ŋ	0.00	0.18	0.00
s	ŋ	0.00	13.09	0.00
ʃ	ŋ	1.00	0.86	1.16
t	ŋ	5.00	17.28	0.29
t͡ʃ	ŋ	0.00	0.20	0.00
v	ŋ	0.00	5.08	0.00
z	ŋ	0.00	18.14	0.00
ʒ	ŋ	0.00	0.20	0.00
θ	ŋ	0.00	1.46	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ɹ	p	0.00	0.07	0.00
s	p	2.00	4.90	0.41
ʃ	p	0.00	0.32	0.00
t	p	5.00	6.46	0.77
t͡ʃ	p	1.00	0.08	13.05
v	p	1.00	1.90	0.53
z	p	0.00	6.79	0.00
ʒ	p	0.00	0.08	0.00
θ	p	0.00	0.55	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
s	ɹ	1.00	0.35	2.88
ʃ	ɹ	0.00	0.02	0.00
t	ɹ	0.00	0.46	0.00
t͡ʃ	ɹ	0.00	0.01	0.00
v	ɹ	0.00	0.13	0.00
z	ɹ	0.00	0.48	0.00
ʒ	ɹ	0.00	0.01	0.00
θ	ɹ	0.00	0.04	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ʃ	s	3.00	1.65	1.82
t	s	5.00	32.89	0.15
t͡ʃ	s	0.00	0.39	0.00

v	s	7.00	9.66	0.72
z	s	62.00	34.54	1.80
ʒ	s	0.00	0.39	0.00
θ	s	8.00	2.77	2.88
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
t	ʃ	2.00	2.17	0.92
t͡ʃ	ʃ	0.00	0.03	0.00
v	ʃ	1.00	0.64	1.57
z	ʃ	1.00	2.28	0.44
ʒ	ʃ	1.00	0.03	38.80
θ	ʃ	1.00	0.18	5.46
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
t͡ʃ	t	0.00	0.51	0.00
v	t	7.00	12.76	0.55
z	t	16.00	45.59	0.35
ʒ	t	0.00	0.51	0.00
θ	t	6.00	3.66	1.64
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
v	t͡ʃ	0.00	0.15	0.00
z	t͡ʃ	0.00	0.54	0.00
ʒ	t͡ʃ	0.00	0.01	0.00
θ	t͡ʃ	1.00	0.04	23.03
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
z	v	12.00	13.40	0.90
ʒ	v	1.00	0.15	6.61
θ	v	2.00	1.08	1.86
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ʒ	z	1.00	0.54	1.85
θ	z	4.00	3.84	1.04
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
θ	ʒ	0.00	0.04	0.00

Appendix D1 – Alternation and expected rates in English vowels

Vowel 1	Vowel 2	Obser.	Expe.	O/E
ə	ɑ	2	2.32	0.86
ɛ	ɑ	1	4.08	0.25
i	ɑ	1	7.17	0.14
ɪ	ɑ	1	5.50	0.18
ɔ	ɑ	9	1.54	5.83
u	ɑ	2	1.72	1.16
ʊ	ɑ	0	0.18	0.00
ʌ	ɑ	12	2.21	5.43
æ	ɑ	4	2.27	1.77
aɪ	ɑ	1	8.00	0.12
aʊ	ɑ	1	1.49	0.67
eɪ	ɑ	1	7.34	0.14
oʊ	ɑ	5	3.15	1.59
ɑɪ	ɑ	5	0.57	8.83
ɜɪ	ɑ	2	0.99	2.02
ɔɪ	ɑ	4	1.09	3.68
əɪ	ɑ	0	2.90	0.00
ɔɪ	ɑ	1	0.26	3.80
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɛ	ə	10	13.11	0.76
i	ə	3	23.06	0.13
ɪ	ə	30	17.69	1.70
ɔ	ə	3	4.96	0.60
u	ə	0	5.53	0.00
ʊ	ə	1	0.56	1.77
ʌ	ə	5	7.11	0.70
æ	ə	4	7.28	0.55
aɪ	ə	0	25.73	0.00
aʊ	ə	0	4.79	0.00
eɪ	ə	3	23.61	0.13
oʊ	ə	4	10.12	0.40
ɑɪ	ə	0	1.82	0.00
ɜɪ	ə	4	3.19	1.26
ɔɪ	ə	1	3.49	0.29
əɪ	ə	17	9.32	1.82
ɔɪ	ə	0	0.85	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
i	ɛ	5	40.56	0.12
ɪ	ɛ	26	31.11	0.84
ɔ	ɛ	0	8.73	0.00
u	ɛ	0	9.72	0.00
ʊ	ɛ	0	0.99	0.00
ʌ	ɛ	6	12.50	0.48
æ	ɛ	22	12.81	1.72
aɪ	ɛ	3	45.25	0.07
aʊ	ɛ	1	8.43	0.12
eɪ	ɛ	44	41.52	1.06
oʊ	ɛ	1	17.80	0.06
ɑɪ	ɛ	3	3.20	0.94
ɜɪ	ɛ	10	5.60	1.78
ɔɪ	ɛ	2	6.14	0.33
əɪ	ɛ	1	16.39	0.06
ɔɪ	ɛ	0	1.49	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɪ	i	67	54.71	1.22
ɔ	i	0	15.35	0.00
u	i	1	17.10	0.06
ʊ	i	0	1.74	0.00
ʌ	i	1	21.99	0.05
æ	i	1	22.53	0.04
aɪ	i	3	79.58	0.04
aʊ	i	0	14.82	0.00
eɪ	i	10	73.01	0.14
oʊ	i	0	31.31	0.00
ɑɪ	i	0	5.63	0.00
ɜɪ	i	1	9.86	0.10
ɔɪ	i	0	10.79	0.00
əɪ	i	0	28.83	0.00
ɔɪ	i	0	2.61	0.00

Vowel 1	Vowel 2	Obser.	Expe.	O/E
ɔ	ɪ	0	11.77	0.00
u	ɪ	1	13.11	0.08
ʊ	ɪ	2	1.34	1.50
ʌ	ɪ	4	16.87	0.24
æ	ɪ	4	17.28	0.23
aɪ	ɪ	3	61.03	0.05
aʊ	ɪ	0	11.36	0.00
eɪ	ɪ	11	55.99	0.20
oʊ	ɪ	1	24.01	0.04
ɑɹ	ɪ	0	4.32	0.00
ɜɹ	ɪ	5	7.56	0.66
ɔɹ	ɪ	1	8.28	0.12
əɹ	ɪ	5	22.11	0.23
ɔɪ	ɪ	0	2.01	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
u	ɔ	0	3.68	0.00
ʊ	ɔ	0	0.38	0.00
ʌ	ɔ	26	4.73	5.49
æ	ɔ	2	4.85	0.41
aɪ	ɔ	1	17.13	0.06
aʊ	ɔ	1	3.19	0.31
eɪ	ɔ	2	15.71	0.13
oʊ	ɔ	21	6.74	3.12
ɑɹ	ɔ	3	1.21	2.48
ɜɹ	ɔ	4	2.12	1.89
ɔɹ	ɔ	17	2.32	7.32
əɹ	ɔ	0	6.20	0.00
ɔɪ	ɔ	1	0.56	1.78
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ʊ	u	4	0.42	9.57
ʌ	u	1	5.27	0.19
æ	u	2	5.40	0.37
aɪ	u	1	19.07	0.05
aʊ	u	3	3.55	0.84
eɪ	u	1	17.50	0.06
oʊ	u	2	7.50	0.27
ɑɹ	u	0	1.35	0.00
ɜɹ	u	1	2.36	0.42
ɔɹ	u	0	2.59	0.00
əɹ	u	0	6.91	0.00
ɔɪ	u	1	0.63	1.60
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ʌ	ʊ	0	0.54	0.00
æ	ʊ	0	0.55	0.00
aɪ	ʊ	0	1.94	0.00
aʊ	ʊ	0	0.36	0.00
eɪ	ʊ	0	1.78	0.00
oʊ	ʊ	1	0.77	1.31
ɑɹ	ʊ	0	0.14	0.00
ɜɹ	ʊ	0	0.24	0.00
ɔɹ	ʊ	0	0.26	0.00
əɹ	ʊ	0	0.70	0.00
ɔɪ	ʊ	0	0.06	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
æ	ʌ	8	6.94	1.15
aɪ	ʌ	2	24.53	0.08
aʊ	ʌ	8	4.57	1.75
eɪ	ʌ	2	22.51	0.09
oʊ	ʌ	12	9.65	1.24
ɑɹ	ʌ	1	1.74	0.58
ɜɹ	ʌ	2	3.04	0.66
ɔɹ	ʌ	4	3.33	1.20
əɹ	ʌ	0	8.89	0.00
ɔɪ	ʌ	1	0.81	1.24
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
aɪ	æ	2	25.13	0.08
aʊ	æ	1	4.68	0.21
eɪ	æ	18	23.06	0.78
oʊ	æ	0	9.89	0.00
ɑɹ	æ	3	1.78	1.69
ɜɹ	æ	1	3.11	0.32

ɔɹ	æ	1	3.41	0.29
əɹ	æ	0	9.10	0.00
ɔɪ	æ	0	0.83	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
aʊ	aɪ	4	16.53	0.24
eɪ	aɪ	5	81.45	0.06
oʊ	aɪ	0	34.93	0.00
ɑɹ	aɪ	6	6.28	0.95
ɜɹ	aɪ	1	10.99	0.09
ɔɹ	aɪ	0	12.04	0.00
əɹ	aɪ	0	32.16	0.00
ɔɪ	aɪ	1	2.92	0.34
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
eɪ	aʊ	0	15.17	0.00
oʊ	aʊ	2	6.50	0.31
ɑɹ	aʊ	5	1.17	4.27
ɜɹ	aʊ	1	2.05	0.49
ɔɹ	aʊ	1	2.24	0.45
əɹ	aʊ	0	5.99	0.00
ɔɪ	aʊ	1	0.54	1.84
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
oʊ	eɪ	1	32.05	0.03
ɑɹ	eɪ	0	5.76	0.00
ɜɹ	eɪ	3	10.09	0.30
ɔɹ	eɪ	0	11.05	0.00
əɹ	eɪ	0	29.51	0.00
ɔɪ	eɪ	0	2.68	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɑɹ	oʊ	0	2.47	0.00
ɜɹ	oʊ	6	4.33	1.39
ɔɹ	oʊ	18	4.74	3.80
əɹ	oʊ	1	12.65	0.08
ɔɪ	oʊ	7	1.15	6.10
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɜɹ	ɑɹ	0	0.78	0.00
ɔɹ	ɑɹ	1	0.85	1.17
əɹ	ɑɹ	0	2.28	0.00
ɔɪ	ɑɹ	0	0.21	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
ɔɹ	ɜɹ	9	1.49	6.03
əɹ	ɜɹ	3	3.98	0.75
ɔɪ	ɜɹ	0	0.36	0.00
Vowel 1	**Vowel 2**	**Obser.**	**Expe.**	**O/E**
əɹ	ɔɹ	2	4.36	0.46
ɔɪ	ɔɹ	2	0.40	5.05
ɔɪ	əɹ	0	1.06	0.00

Appendix D2 – Alternation and expected rates in English consonants

Cons. 1	Cons.2	Obser.	Expe.	O/E
d	b	1	0.60	1.66
ð	b	0	0.02	0.00
d͡ʒ	b	0	0.04	0.00
f	b	1	0.06	16.82
g	b	0	0.01	0.00
k	b	1	0.14	7.21
l	b	0	0.36	0.00
m	b	1	0.21	4.78
n	b	0	0.89	0.00
ŋ	b	0	0.16	0.00
p	b	0	0.06	0.00
ɹ	b	0	0.00	0.00
s	b	0	0.33	0.00
ʃ	b	0	0.02	0.00
t	b	0	0.40	0.00
t͡ʃ	b	1	0.01	77.99
v	b	1	0.13	7.66
z	b	0	0.48	0.00
ʒ	b	0	0.00	0.00
θ	b	0	0.05	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ð	d	3	2.87	1.05
d͡ʒ	d	9	4.90	1.84
f	d	9	7.69	1.17
g	d	1	1.43	0.70
k	d	8	17.95	0.45
l	d	13	47.05	0.28
m	d	9	27.07	0.33
n	d	25	115.37	0.22
ŋ	d	1	21.26	0.05
p	d	4	7.77	0.52
ɹ	d	0	0.30	0.00
s	d	11	42.91	0.26
ʃ	d	1	2.04	0.49
t	d	60	51.73	1.16
t͡ʃ	d	1	1.66	0.60
v	d	22	16.89	1.30
z	d	45	62.43	0.72
ʒ	d	0	0.45	0.00
θ	d	8	7.09	1.13
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
d͡ʒ	ð	0	0.18	0.00
f	ð	0	0.28	0.00
g	ð	0	0.05	0.00
k	ð	0	0.66	0.00
l	ð	1	1.73	0.58
m	ð	1	0.99	1.01
n	ð	2	4.24	0.47
ŋ	ð	0	0.78	0.00
p	ð	0	0.29	0.00
ɹ	ð	0	0.01	0.00
s	ð	1	1.58	0.63
ʃ	ð	0	0.07	0.00
t	ð	2	1.90	1.05
t͡ʃ	ð	0	0.06	0.00
v	ð	7	0.62	11.29
z	ð	1	2.29	0.44
ʒ	ð	0	0.02	0.00
θ	ð	1	0.26	3.84
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
f	d͡ʒ	1	0.48	2.07
g	d͡ʒ	1	0.09	11.11
k	d͡ʒ	1	1.13	0.89
l	d͡ʒ	2	2.95	0.68
m	d͡ʒ	1	1.70	0.59
n	d͡ʒ	0	7.25	0.00
ŋ	d͡ʒ	1	1.34	0.75
p	d͡ʒ	0	0.49	0.00
ɹ	d͡ʒ	0	0.02	0.00

s	d͡ʒ	5	2.69	1.86
ʃ	d͡ʒ	2	0.13	15.64
t	d͡ʒ	2	3.25	0.62
t͡ʃ	d͡ʒ	0	0.10	0.00
v	d͡ʒ	6	1.06	5.66
z	d͡ʒ	5	3.92	1.28
ʒ	d͡ʒ	0	0.03	0.00
θ	d͡ʒ	0	0.45	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
g	f	0	0.14	0.00
k	f	1	1.77	0.57
l	f	0	4.64	0.00
m	f	7	2.67	2.62
n	f	2	11.37	0.18
ŋ	f	0	2.10	0.00
p	f	2	0.77	2.61
ɹ	f	0	0.03	0.00
s	f	9	4.23	2.13
ʃ	f	0	0.20	0.00
t	f	14	5.10	2.75
t͡ʃ	f	0	0.16	0.00
v	f	4	1.66	2.40
z	f	8	6.15	1.30
ʒ	f	0	0.04	0.00
θ	f	0	0.70	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
k	g	1	0.33	3.04
l	g	0	0.86	0.00
m	g	0	0.50	0.00
n	g	1	2.12	0.47
ŋ	g	2	0.39	5.12
p	g	0	0.14	0.00
ɹ	g	0	0.01	0.00
s	g	3	0.79	3.81
ʃ	g	0	0.04	0.00
t	g	0	0.95	0.00
t͡ʃ	g	1	0.03	32.84
v	g	2	0.31	6.45
z	g	0	1.15	0.00
ʒ	g	0	0.01	0.00
θ	g	0	0.13	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
l	k	1	10.82	0.09
m	k	1	6.22	0.16
n	k	9	26.53	0.34
ŋ	k	0	4.89	0.00
p	k	11	1.79	6.16
ɹ	k	0	0.07	0.00
s	k	5	9.87	0.51
ʃ	k	2	0.47	4.27
t	k	27	11.89	2.27
t͡ʃ	k	0	0.38	0.00
v	k	1	3.88	0.26
z	k	3	14.36	0.21
ʒ	k	1	0.10	9.61
θ	k	1	1.63	0.61
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
m	l	10	16.32	0.61
n	l	43	69.56	0.62
ŋ	l	3	12.82	0.23
p	l	2	4.68	0.43
ɹ	l	1	0.18	5.50
s	l	6	25.87	0.23
ʃ	l	1	1.23	0.81
t	l	7	31.19	0.22
t͡ʃ	l	0	1.00	0.00
v	l	2	10.18	0.20
z	l	2	37.64	0.05
ʒ	l	2	0.27	7.33
θ	l	0	4.27	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
n	m	125	40.02	3.12

ŋ	m	3	7.38	0.41
p	m	1	2.69	0.37
ɹ	m	0	0.10	0.00
s	m	0	14.88	0.00
ʃ	m	1	0.71	1.42
t	m	7	17.94	0.39
t͡ʃ	m	0	0.58	0.00
v	m	17	5.86	2.90
z	m	7	21.66	0.32
ʒ	m	0	0.16	0.00
θ	m	1	2.46	0.41
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ŋ	n	25	31.43	0.80
p	n	4	11.48	0.35
ɹ	n	0	0.45	0.00
s	n	18	63.42	0.28
ʃ	n	2	3.01	0.66
t	n	11	76.47	0.14
t͡ʃ	n	1	2.45	0.41
v	n	13	24.97	0.52
z	n	9	92.29	0.10
ʒ	n	1	0.67	1.50
θ	n	7	10.48	0.67
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
p	ŋ	0	2.12	0.00
ɹ	ŋ	0	0.08	0.00
s	ŋ	0	11.69	0.00
ʃ	ŋ	0	0.55	0.00
t	ŋ	4	14.09	0.28
t͡ʃ	ŋ	0	0.45	0.00
v	ŋ	1	4.60	0.22
z	ŋ	5	17.01	0.29
ʒ	ŋ	0	0.12	0.00
θ	ŋ	0	1.93	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ɹ	p	0	0.03	0.00
s	p	3	4.27	0.70
ʃ	p	0	0.20	0.00
t	p	10	5.15	1.94
t͡ʃ	p	1	0.17	6.06
v	p	3	1.68	1.78
z	p	2	6.21	0.32
ʒ	p	0	0.05	0.00
θ	p	3	0.71	4.25
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
s	ɹ	0	0.17	0.00
ʃ	ɹ	0	0.01	0.00
t	ɹ	0	0.20	0.00
t͡ʃ	ɹ	1	0.01	155.98
v	ɹ	1	0.07	15.32
z	ɹ	0	0.24	0.00
ʒ	ɹ	0	0.00	0.00
θ	ɹ	0	0.03	0.00
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ʃ	s	5	1.12	4.47
t	s	9	28.44	0.32
t͡ʃ	s	2	0.91	2.19
v	s	4	9.29	0.43
z	s	41	34.32	1.19
ʒ	s	0	0.25	0.00
θ	s	6	3.90	1.54
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
t	ʃ	0	1.35	0.00
t͡ʃ	ʃ	1	0.04	23.11
v	ʃ	0	0.44	0.00
z	ʃ	2	1.63	1.23
ʒ	ʃ	1	0.01	84.73
θ	ʃ	3	0.18	16.22
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
t͡ʃ	t	0	1.10	0.00
v	t	8	11.20	0.71
z	t	10	41.38	0.24

ʒ	t	0	0.30	0.00
θ	t	14	4.70	2.98
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
v	t͡ʃ	1	0.36	2.79
z	t͡ʃ	0	1.33	0.00
ʒ	t͡ʃ	0	0.01	0.00
θ	t͡ʃ	1	0.15	6.64
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
z	v	10	13.51	0.74
ʒ	v	0	0.10	0.00
θ	v	1	1.53	0.65
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
ʒ	z	1	0.36	2.76
θ	z	3	5.67	0.53
Cons. 1	**Cons.2**	**Obser.**	**Expe.**	**O/E**
θ	ʒ	0	0.04	0.00

Appendix E - Vowel Deletion Rates in US and UK English

US English Vowel Deletions in the Corpus

Stressed vowel deletions		**Unstressed vowel deletions**	**Total Deletions**	**Total Vowel appearance**	Percentage out of vowel's appearances
əɹ	0	19	19	221	9%
ə	0	12	12	201	6%
ɑɹ	2	0	2	32	6%
ɪ	0	3	3	433	0.7%
ɛɹ	1	0	1	78	1%
ɔɹ	1	0	1	86	1%
u	0	1	1	120	0.8%
eɪ	3	0	3	509	0.6%
oʊ	2	1	3	227	1%
i	2	0	2	590	0.3%
aɪ	1	0	1	585	0.2%
Undeleted vowels		ɒ, ɛ, ʌ, ʊ, ə, æ, aʊ, ɔɪ		874	0%
Sum	12	36	48	3,956	1%

UK English Vowel Deletions in the Corpus

Stressed vowel deletions		**Unstressed vowel deletions**	**Total Deletions**	**Total Vowel appearance**	Percentage out of vowel's appearances
əɹ	0	26	26	209	12%
ə	0	7	7	143	5%
ɪ	0	7	7	383	2%
ɛɹ	1	0	1	69	1%
ɔɹ	1	0	1	75	1%
u	1	0	1	135	0.7%
eɪ	5	0	5	580	0.8%
i	2	1	3	474	0.6%
aɪ	1	0	1	602	0.2%
ʊ	1	0	1	14	7%
ɔ	1	0	1	106	0.9%
Undeleted vowels		ɒ, ɛ, ʌ, æ, ɑr, aʊ, ɔɪ, oʊ		1,189	0%
Sum	13	41	54	3,979	1%

Appendix F - Consonant Deletion Rates in US and UK English

US English Consonantal Deletions in the Corpus

Cons.	Stressed	Unstressed	Total Deletions	Total appearances	Percentage (of appearances)
b	1	0	1	2	50%
d	137	4	141	533	26.5%
ð	5	0	5	32	16%
d͡ʒ	3	0	3	32	9%
f	16	0	16	55	29%
g	2	0	2	9	22%
k	21	0	21	116	18%
l	42	3	45	346	13%
m	25	0	25	141	18%
n	87	12	99	692	14%
ŋ	17	4	21	192	11%
p	9	0	9	51	17%
s	29	3	32	252	13%
ʃ	0	1	1	18	5.5%
t	35	5	40	335	12%
t͡ʃ	1	0	1	12	8%
v	31	0	31	110	28%
z	158	12	170	411	41%
θ	7	0	7	38	18%
Undeleted consonants			j, t͡ʃ, ɹ, w, ʒ	4	0%
Sum	626	44	670	3,381	20%

UK English Consonantal Deletions in the Corpus

Cons.	Stressed	Unstressed	Total Deletions	Total appearances	Percentage (of appearances)
b	1	0	1	6	17%
d	110	6	116	502	23%
ð	3	0	3	15	20%
d͡ʒ	2	0	2	33	6%
f	7	0	7	47	15%
k	13	1	14	122	11.5%
l	41	2	43	278	15.5%
m	30	0	30	218	14%
n	80	3	83	838	10%
ŋ	10	1	11	90	12%
p	8	0	8	52	15%
s	44	3	47	317	15%
t	48	3	51	351	14.5%
v	14	1	15	114	13%
z	171	14	185	417	44%
ʒ	1	0	1	4	25%
θ	4	0	4	56	7%
Undeleted consonants			j, t͡ʃ, ɹ, w, g, ʃ	31	0%
Sum	587	34	621	3,491	17%

תקציר

מחקר זה בוחן את השפעת שפת האם (L1) על דמיון פונולוגי נתפש בשפה שנייה (L2). באמצעות ניתוח נתונים שנאספו לקורפוס רחב היקף של חרוזים במילות שירי מטאל שנכתבו באנגלית, המחקר משווה את דפוסי החריזה של חרוזים לא מושלמים, בין דוברי עברית וגרמנית כשפת אם, הכותבים באנגלית כשפה שניה, לבין קבוצת ביקורת של דוברי אנגלית כשפת אם.

על ידי בחינה זאת, אני מציעה מיפוי של עקרונות אוניברסליים בדפוסי החריזה, דוגמת דמיון בין עיצורים סונורנטיים, לצד השפעות ספציפיות לשפת האם, דוגמת דפוסי תנועות בעברית או השפעת תופעת אובדן הקוליות בסוף מילה (Final Devoicing) בגרמנית. נמצא כי לכל הממצאים הללו השפעה ניכרת על תפישת הדמיון בעת יצירת חרוזים בשפה שנייה.

אוניברסיטת תל אביב

הפקולטה למדעי הרוח ע"ש לסטר וסאלי אנטין

החוג לבלשנות

רק חרוז עם היגיון

דמיון פונולוגי באנגלית כשפה שנייה (L2) בשירי מטאל: בחינת דפוסי חריזה בין דוברי שפת אם לדוברי שפה שנייה

חיבור זה הוגש כעבודת גמר לקראת התואר

"מוסמך אוניברסיטה" - M.A. באוניברסיטת ת"א

על ידי ניצן כהן-אבני

העבודה הוכנה בהדרכת:

ד"ר אוון-גרי כהן

דצמבר 2025